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Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

CONTENTS.

An Asterisk (*) Denotes an Illustrated Article.

NOTICE—
Wrinkle Department, American Gas Institute. 473

EDITORIALS—
Briefly Told 473
The Eighteenth Annual Meeting of the Michigan Gas Association—Current Mention.
*Extension of Artistic Show Window Lights, by "R." 475
*The Comparative Values of Various Coatings and Coverings for the Prevention of Soil and Electrolytic Corrosion of Iron Pipe, by Mr. R. B. Harper—Continued from Page 431 475
*The Glover and West Vertical Retorts at St Helens—Continuous Working with Gravity Charging—Continued from Page 435..... 479
*Laying a Subaqueous Reinforced Concrete Pipe with Cast Iron Flange Connection 482
The Significance of Drafts in Boiler Operation..... 482
Electric Furnaces in Germany..... 483
Latest British Wiring Rules..... 484
Notes on Warming and Ventilation..... 485
ITEMS OF INTEREST FROM VARIOUS LOCALITIES..... 486
Annual Meeting, Superior, Wis.—Death of Mr. David Coleman—Annual Meeting, Kalamazoo, Mich.—Money Appropriated for Betterments, Danville, Ills.—Havelock, Neb., Wants a Gas Works—The Gas Companies will Hold the Rebates—Personal—New Office Building, Springfield, Mass.—Gas Works for Raton, New Mexico—Also for Saranac Village, N. Y.—A Site Worth Seeing—Annual Meeting, New Bedford, Mass.—Maximum Sulphur Content, Massachusetts Gas—A New Trial in an Old Suit, Los Angeles—Eking Out the Public Lighting, Boston—Once More, the Doherty Syndicate—Some Personals—And Other Items.
The Market for Gas Securities..... 488

[NOTICE.]

Wrinkle Department, American Gas Institute.

WRINKLE DEPARTMENT, AMERICAN GAS INSTITUTE,
OFFICE OF EDITOR, GAS OFFICE BUILDING,
DETROIT MICH, March 12th, 1909.

To the Members, American Gas Institute: All members of the American Gas Institute are earnestly requested to forward contributions for the Wrinkle Department as soon as possible.

Your co-operation determines the success of the Department.

F. L. CROSS, Editor.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

BRIEFLY TOLD.

THE EIGHTEENTH ANNUAL MEETING OF THE MICHIGAN GAS ASSOCIATION.—Secretary Ewing has forwarded to the members this week two circulars regarding the 18th annual meeting of the Michigan Gas Association, which go to show that the officers, from youthful "Jim" Lynn down, have been successful in their determination to hold the convention out of sight of land for the three days beginning September 14th. One of the staunch steamers of the "D. & C. Line" has been chartered, and every detail that could be thought of for the comfort of the voyagers has been arranged. The literary part of the programme so far revealed shows these numbers:

"How We Sold Our Surplus Coke," by Mr. Glen R. Chamberlain, Grand Rapids, Mich.

"Studies in Coal Distillation," by Prof. Alfred H. White and Messrs. John H. Lyman and Wm. A. Dunphy, of the University of Michigan.

"Retort Benches," by Mr. A. S. B. Little, St. Louis, Mo.

"Report of Co-operative Illuminating Gas Tests," submitted to the Directors of the U. S. Geological Survey by Mr. Perry Baker, Assistant Engineer.

Possibly it would be just as well to here reproduce the "Circular-in-Blue," issued under the seal of Secretary and Treasurer Ewing, respecting the meeting and its promises. It certainly tells the story in better shape than anyone on the JOURNAL'S staff could do it, and some of its paragraphs surely read as if President Lynn had quite a pen in them. Here they are:

MICHIGAN GAS ASSOCIATION,
GAS OFFICE BUILDING,
DETROIT, MICH., August 11, 1909.

We have engaged the boat for September 14, 1909, to leave at 9 A.M.

It is no longer a question of "Will we have enough?" It is now a question whether we can take care of all those who want to go.

If you have any additional reservations to make—make them quick.

Remember, it's a STAG affair.

We have 163 staterooms and parlors, and in order that there may be no partiality shown, it has been decided that to those who want staterooms all by themselves, we will make an extra charge of $3 per ticket.

You don't need a stateroom all by yourself; don't think that for a minute; because each stateroom has two large berths; a very wide three-quarter lower berth and a broad upper berth. We will not sell to exceed 50 rooms for single use.

We have four parlors (one of them by the way has already been taken), and if perchance you feel aristocratic and want to live in a parlor for three days, we are going to charge $30 for the ticket which includes that parlor. This means $8 extra. Not because we need the money, but because we have to have some way to find out who wants a parlor bad enough to pay a little extra for it.

We have made arrangements to print our programme right on board the boat. Each morning when you get up, instead of finding the morning's paper tucked carefully in your door, you will find the day's programme, telling you just where we will be, what time the papers will be read, what time the discussions will take place. It will give

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you full information about the band concerts and all the entertainment features.

There are two good reasons for attending the Michigan Gas Association convention: One is because we will give you papers that are well worth while; the second is, that you will get better acquainted with your fellow gas men, and have an opportunity to get from them the kind of information that will help you in your business.

You never had an opportunity to spend $22 to so good advantage for your Company as you have this year by attending the Michigan Gas Association convention.

For the last three or four years we have had to hold our meetings in rooms that were heated above normal. Most of us sat with our coats off trying to think and trying to keep cool. Now we have a quiet, cool place for the meeting. No annoyance to disturb us, and it's bound to be pleasant and airy.

Mixed in between the sessions you will have an opportunity to view scenery, that is second to none in the United States, in point of beauty or in point of interest. If you haven't seen the Soo with all its interesting engineering, or if you haven't been through the St. Marys river or St. Clair flats, can you afford to let this chance go by?

Now, remember, we don't want over 225 on the trip. We don't intend to crowd the boat. To those who want to reserve their staterooms now we give this privilege. Make a deposit of $10 and we will send you a chart of the boat, you in turn to mark the staterooms that you would prefer, and we will at once make reservation as near to your choice as possible. First come first served.

We do not, however, leave this opportunity open after September 1st. It will be impossible to make specific reservations of staterooms after that date. When you reach Detroit on the 14th, make your reservations on the boat.

Note the list of those who have already subscribed for tickets. See if you don't see the most enthusiastic bunch of gas men that you ever heard of at one time attending one of these meetings.

If you are a supply man, remember, there is an opportunity for you to display your goods on the baggage deck on the boat, but by all means let the Secretary know in advance so that he may see to it that there is plenty of room for all.

But just as a reminder: You get all of the day's happenings in the morning bulletin, and you get the baseball score in the afternoon on the bulletin board. All of this information will come to us by the Clark Wireless Telegraphy. ALONZO P. EWING, Secretary.

CURRENT MENTION.——

MR. CARROLL MILLER has resigned the position of Engineer to the Consolidated Gas Company, of Pittsburgh, Pa., to accept the task of superintending the construction of the new plant that is to be erected by the Providence (R. I.) Gas Company.

MR. GEORGE OLD has resigned the superintendency of the St. Augustine (Fla.) Gas Company, to take up permanent residence in Bellhaven, N. C., where he proposes to engage in business with his brother-in-law, Mr. Charles P. Aycock, who is one of the best known financiers in North Carolina. We wish him all possible success, the measure of which certainly shall be large, if the success which attended his careful ways in the conduct of the business of the St. Augustine Gas Company may be taken as a criterion.

THIS information is authentic respecting the changes determined upon by the Geist syndicate in connection with its recent purchase of the properties of the Wilmington (Del.) Gas and Electric Company. The announcements were prepared the 5th inst. and became effective immediately:

"Mr. Edmund Mitchell has resigned the active management of the Wilmington Gas and Electric Company, and Mr. Harold S. Schutt has been appointed Active Manager in Mr. Mitchell's place. The latter will remain Vice-President of the Wilmington Gas and Electric Company, and will have general supervision over its policy. The C. H. Geist Company is putting in a branch office for the handling of its different securities in Wilmington, and Mr. Mitchell will assume the position of Resident Manager of the C. H. Geist Company.

"The Wilmington Gas and Electric Company will move its offices to Fifth and Orange streets while its new building is being erected. The C. H. Geist Company will have its offices in the same building, at Fifth and Orange streets, as the Wilmington Gas and Electric Company, pending building operations, where Mr. Mitchell will temporarily have an office, and in addition to his office as Vice-President of the Wilmington Gas and Electric Company, he will have entire charge of the sale of its securities. When the new gas office building is completed a suite of offices will be retained by the C. H. Geist Company on the second floor. The C. H. Geist Company's main office is in 1127 Land Title Building, Philadelphia. It has branch offices in Chicago and Grand Rapids.

"Mr. Schutt has been transferred from the management of the Michigan City Gas and Electric Company, where he has been for the past 3 years, to the active management of the Wilmington Gas and Electric Company. Formerly Mr. Schutt was Manager at Mahanoy City, Pa., Hammond, Ind., and Chicago Heights, Ills."

ON Saturday, July 31st, the plant of the Mueller Manufacturing Company, at Decatur, Ills., was closed and the members of the Company, their employees and families went to Miller Park, Bloomington, Ills., for a day's outing. Some 250 persons were especially invited as guests of the Company. These included Mayor C. M. Borchers, the City Council, city officials, master plumbers, journeymen plumbers and their families. Four special interurban trains were used in transporting the party to the scene of the festivities 40 miles distant. At Bloomington the party was met by the Business Men's Association, Mayor Carlock and the City Council. The Mueller employees wore a handsome blue badge to distinguish them from the guests who were provided with red badges. Forty or 50 Bloomington automobiles, followed by a platoon of police, acted as an escort to the visitors who paraded the streets to Miller Park. Goodman's Fourth Regiment Band, a celebrated Central Illinois musical organization, furnished music. There were six large American flags in the parade and each staff was surmounted by pieces of Mueller brass goods. Red, white and blue pennants, bearing the word "Mueller," were carried on bamboo canes by the employees and the parade was quite an imposing affair. Arriving at Miller Park the employees scattered beneath the shade trees and enjoyed a picnic dinner. A band concert, athletic events, on land and lake, filled out a happy day. After supper the company danced at the pavilion, returning home by late trains on the interurban. The Aid Society, which had active charge of the affair, is an organization formed for mutual benefit by Mueller employees. There is a death and sick benefit. The Mueller Company encourages and supports the society in every undertaking, and we think it is only telling the plain truth when we say that no other manufacturing company in the country is in closer, happier touch with its men.

THIS year's outing (the third) of the employees of the Lynn (Mass.) Gas and Electric Club was brought off at Lily Pond Grove, Saugus, the afternoon of July 22d, and when the homeward way was reached it was voted that the third time was the best time. Special cars were provided to take the party to the Grove, and certainly not less than 300 were thus carried. The main or opening attraction was a game of baseball between nines from each division of the Company's trading, known respectively, as the "Electric Sparks" *vs.* "Gas Meters," which game, by-the-way, went to the former in the last inning, the final score being 9 to 8. Luncheon having been served the balance of the afternoon was given over to a series of contests that furnished much amusement and great excitement, notably the tug-of-war between the teamsters and linemen. The contest was won by the latter. The invited guests who responded to the invitation included General Manager Charles F. Prichard, Treasurer Eugene B. Fraser, Director Charles H. Baker, Frank W. Mace, Superintendent of the gas department, and the Ancient and Honorable Mr. John M. Vennard, of the collection division. The success of the outing was in no small manner due to the activities of the following named gentlemen who composed the General Committee: Chairman, B. S. Courtney; Secretary and Treasurer, P. F. Moran, and Messrs. Alexander Wallace, M. F. Moran, R. D. Deenan, George P. Young and O. F. Dressell.

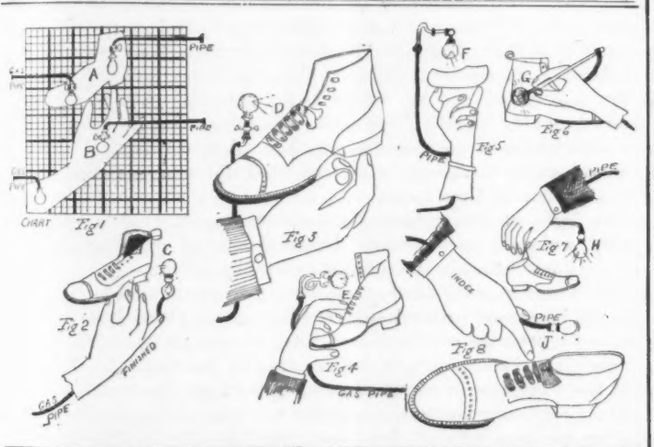
WE welcome to our table the first issue (Vol. 1, No. 1) of the Pacific "Gas and Electric Magazine," which is to be published hereafter each month by the Pacific Gas and Electric Company, of San Francisco. As set out in its editorial page the publication is to appear each month, and it is published in the interests of the employees of the San Francisco Gas and Electric Company, by the following staff: Editor, John A. Britton—naturally, properly, unavoidably the proper selection; News Editor, R. J. Cantrell—unknown to us personally; but we are certain to become better acquainted; Business Manager, Mr. A. F. Hockenbeamer. If the first number is to be a sample of its successors, then the older ones in the field of gas journalism will have to keep moving, for its reading pages (of which there are 32) are replete with matter of interest. In fact, to prove our faith in it, last week we reproduced from its pages an excellent description of "The Application of Reinforced Concrete Piling," by Mr. H. C. Vensano, and other excellent articles in it were by men known the world over—for instance, John A. Britton, C. F. Adams, Jno. Clements, Chas. L. Barrett, *et al.* The frontispiece is a handsome reproduction in black and white of the beautiful new office home-to-be of the Company, in 445 Sutter street. We wish our newest contemporary a long and useful life.

Extension of Artistic Show Window Lights.

[Communicated by "R."]

The development of intricate and striking show window gas arc and electrical lighting has surely been wonderful in the past few years. Formerly the gas lighting engineer who contracted to provide certain lighting facilities for windows in which a display of goods had to be made, simply sought to furnish a certain amount of light, free from shadows, and of sufficient brilliancy to properly illuminate the window, the goods and the surroundings. But it is different now; illumination is what attracts and brilliantly illumined store fronts are fashionable. The storekeeper demands that the window illumination shall extend beyond the store front to light up the sidewalk, while some go so far as to require plans for the lighting of the street in front of the store. The well lighted street front tends to invite persons in motors and other vehicles to stop there. As a result, on the changing requirements in window lighting demands from enterprising occupiers of stores, gas lighting engineers have made a study of the art of trick lighting, fancy lighting, freak lighting, advertising lighting, sales lighting, street front lighting, sign lighting, etc. Indeed there appears to be no limit to the scope of the work along these lines. In this article we will touch upon one department of the store window lighting which just now interests dealers.

Catch-lighting appeals to the eyes of certain people. A light that mysteriously goes up, then on again, is pretty sure to catch the eye of the passer. Lights that bob up back of colored glass and then become dim again by mechanical devices are also in this class. Fig. 1 illustrates a kind of special lighting utilized by the advertising department of certain large establishments. The outline of figures of goods is made in profile on a drop curtain. Lights are adjusted in the back, as at *A* and *B*. The usual cam method of making the light go down low and then become brilliant again is used, hence the effect in front may be an ordinary scene of a windmill or pasture view, but when the lights go on, the forms of the shoes, hats or other articles are shown in outline by the lights in the rear, for the heavy coating of paint making up the landscape on the front of the curtain, is transparent within the lines of the forms.



Another system requires the use of a revolving arm, through which a gas pipe is run to the light, terminating at the finger tip, as at *C*, Fig. 2. This provides a special light for the article to be exhibited.

Styles of inverted gas lights are used. Half-frosted globes are utilized with good results. Fig. 3 shows the plan for getting the light, as at *D*. The special light is often richly decorated on the globe, and some pretty effects are shown.

Fig. 4 illustrates another combination. In one place, where a line of wooden shoes was advertised, the light globe hung over the odd little hardwood specimen, as at *F*, Fig. 5. In another model a hand was used with a stem, as if indicating a certain point on a shoe, as at *G*, Fig. 6. Fig. 7 shows a suspended combination with the light at *H*. In Fig. 8 the object is to note the style of string in the shoe. Hence the light is fixed at *j*.

Some very ingenious combinations are possible. The article to be advertised is usually taken from the stock direct. The hand is a model secured from manufacturers, and ordinarily covered with a kid glove. Instead of hands, the pipes often carry the globe direct to the object. Sometimes artistically shaped ornamental bronze or other metal fixtures are used instead of hands. In fact, numbers of different processes are used.

[Continued from Page 431.]

The Comparative Values of Various Coatings and Coverings for the Prevention of Soil and Electrolytic Corrosion of Iron Pipe.

[A paper prepared by Mr. Robert B. Harper, for the Illinois Gas Association.]

In accordance with the previous statement, a metal immersed in water goes into solution until the solution tension of the metal is equalized by the osmotic pressure of the liquid containing the dissolved metal, in much the same manner as a liquid in contact with a gas vaporizes until the partial pressure of its vapor above the liquid equalizes the vapor tension of the liquid itself.

A substance which, dissolved in a liquid, will conduct electricity is known as an electrolyte. Electrolytes may be either gaseous, liquid or solid substances, which, when dissolved in some solvent, act as electrical conductors. As a rule, the greater the concentration of the electrolyte, the greater the current flow of electricity, but the rate of increase of current flow is usually not as great as that of concentration. A warm solution of an electrolyte usually conducts better than a cold solution of the same concentration. In this connection, Hopkins[1] has shown us by experiment that frozen solutions of electrolytes practically stop the flow of electricity.

Substances are thought to exist in solution in two states, namely, molecular and ionic. Thus, sodium chloride (NaCl), when dissolved in water, exists partially as sodium chloride (NaCl) molecules and partially as sodium (+Na) and chlorine (—Cl) ions. It may be stated that, as a rule, the lower the concentration of a dissolved substance, or the greater the dilution, the larger will be the percentage of the dissolved substance existing as ions.

It might be well to add that water, the usual solvent for electrolytes or other substances, is itself partially ionized into a hydrogen ion (+H) and a hydroxyl ion (—OH). The hydrogen ion is positive and has the characteristics of a metallic ion, while the hydroxyl ion is negative, in manner similar to the ions composed of non-metallic elements.

Ions are not to be confused with atoms. An ion may consist of either one or more atoms of one or a number of elements. One of the characteristic features of the ion is the charge of electricity which it is supposed to carry. As a rule, ions made up of metallic elements carry positive charges of electricity, while those formed from non-metallic elements bear negative charges. When an ion is so constituted that it contains both metallic and non-metallic elements, it usually takes on the characteristics of that group of elements which is in the majority as regards their charges of electricity.

The ions are supposed to be the means by which electricity is conducted through a solution. They are divided into two classes, called anions and cations according to their behavior under the action of an electric current. Those ions which migrate to the positive electrode or anode, from which the electric current is passing into the solution, are termed anions, while those ions travelling with the current toward the negative electrode or cathode are called cations. The anions are usually made up of non-metallic elements, while the cations are formed from the metallic elements.

The non-metallic elements include oxygen, nitrogen, sulphur, phosphorus, fluorene, chlorine, bromine, iodine and carbon, which are among the chief constituents of acids, while the metallic elements embrace potassium, sodium, calcium, magnesium, zinc and iron, which are some of the principal base-forming compounds.

When electrical current passes through a solution, and the electrolyte is decomposed, the action is called electrolysis. According to Arrhenius,[2] this action often consists of two kinds, namely, primary electrolysis and secondary electrolysis. The electrolysis of a sodium chloride (NaCl) solution between platinum electrodes will serve to distinguish between the two. In this case the sodium ions migrate to the negative electrode and are deposited upon the cathode as metallic sodium, while the chlorine ions migrate to the positive electrode and are deposited upon the anode as gaseous chlorine. This part of the action is called primary electrolysis. As metallic sodium readily acts upon water, the two at once cause a chemical change with the forma-

1. "Experimental Electrochemistry." N. Monroe Hopkins.
2. Text Book of Electrochemistry." Arrhenius. Translated by John McCrae; p. 8.

tion of sodium hydroxide, or caustic soda and hydrogen, and similarly, the chlorine on the anode acts upon the water and liberates oxygen, forming hydrochloric acid. These secondary actions are termed secondary electrolysis.

In the foregoing example the hydrogen liberated at the cathode may form a thin film and tend to decrease the flow of electricity from the anode, through the solution, to the cathode. The oxygen liberated at the anode may act similarly in tending to minimize the electrical current flow. These films create electromotive forces which act counter to the electromotive forces existing initially. Polarization is the term used to define the condition just described, where a gas forms a thin film on an electrode and produces an electromotive force counter to that existing previous to the formation of the film.

That the electromotive forces set up by the films of hydrogen, oxygen and other elements tend to change the differences of potential existing between the electrodes and the solution, is readily understood when we consider the fact that hydrogen, which acts as a metal and is electro-positive, is usually deposited upon the cathode, or electrode having the weaker solution tension with reference to the solution, and hence increases the difference in potential existing between the cathode and the solution. Oxygen, too, plays its part as an electro-negative element by depositing itself upon the anode, or positive electrode having the stronger solution tension with reference to the solution, thus tending to decrease the difference in potential existing between the anode and the solution.

This polarization effect of oxygen upon iron is believed by some to explain the so-called "passivity" or resistivity of that metal to corrosion. It is known that a passive condition of iron is produced when this metal is immersed in such oxidizing agents as strong solutions of nitric acid, chromic acid and potassium dichromate.

The elements causing polarization may either act upon, or be acted upon, by the electrodes, the electrolytes or the solvent. The rapidity with which each secondary action or de-polarization takes place governs the strength of the electrical current flow through the solution from one electrode to another.

Again, considering the subject of the solution tension of metals, we find that a metal, when immersed in a solution of one of its salts, may have a solution tension greater than, equal to, or less than the osmotic pressure of the salt in solution.

When the metal has a solution tension greater than the osmotic pressure of the salt in solution, it will, upon immersion in the solution, send metallic ions bearing positive charges of electricity from the formerly neutral metal itself, which, consequently, becomes negative to the solution. At the plane of contact between the metal and the solution a so-called electrical double layer[1] is formed, due to the attraction of the positively charged ions in solution for the negatively charged metal. This double layer tends to drive back the metallic ions from the electrolytes to the metal, in direct opposition to the solution tension of the metal. When these two opposing forces are equal, a condition of equilibrium is reached, with the result that an electromotive force exists between the negative metal and the positive solution.

From the foregoing explanation it can be readily seen that as many ions cannot pass from a metal into a solution of one of its salts as into pure water, because the osmotic pressure of the ions already in solution acts in opposition to the solution tension of the metal. When the metal has a solution tension just equal to the osmotic pressure of the metallic ions in solution, equilibrium is established as soon as the metal is immersed in the solution and no difference in potential exists between the metal and the solution.

When the solution tension of the metal is less than the osmotic pressure of the metallic ions in the solution, the metal, formerly neutral, upon immersion in the solution becomes positively charged, due to the separation of the metallic ions from the solution as metallic atoms deposited upon the metal. The electrical double layer is formed at the plane of contact between the metal and the solution, as in the first case, with the difference that the metal is now positive to the solution. Equilibrium is established when the excess osmotic pressure of the metallic ions in solution over the solution tension of the metal is just equalized by the electro-static force of the electrical double layer, which tends to prevent metallic ions from passing out of solution. As in the first case considered, the result of an establishment of equilibrium is an electromotive force between the metal and the solution. This electromotive force acts in the reverse direction than in the first case considered.

1. "Ztschr. Phys. Chem.," Vol. 4, p. 150 (1889). Helmholtz.

Table I., obtained from Ostwald, shows the values of and relations existing between the solution pressures of various metals and the potential differences existing between metals and their normal salt solutions.

TABLE I.

Metal.	Symbol.	Potential Difference in Volts.	Solution Pressure in Atmosphere.
Magnesium	Mg	+ 1.22	10^{44}
Zinc	Zn	+ .51	10^{18}
Aluminum	Al	+ .22	10^{13}
Cadmium	Cd	+ .19	10^{7}
Iron	Fe	+ .06	10^{3}
Nickel	Ni	— .02	10^{0}
Lead	Pb	— .10	10^{-2}
Hydrogen	H	— .25	10^{-4}
Copper	Cu	— .60	10^{-12}
Mercury	Hg	— .99	10^{-18}
Silver	Ag	— 1.01	10^{-18}

The foregoing table shows that metals like magnesium, zinc, and aluminum have high solution tensions and, in the presence of the normal solutions of their salts, give positive differences of potential, while copper, mercury and silver have low solution tensions and exhibit negative differences of potential when immersed in their normal salt solutions. For a better understanding of these facts let us take, for example, the case of zinc. Zinc, when immersed in a normal solution of zinc sulphate, is positive to the solution by about .5 volt. Owing to the fact that its solution pressure is much greater than the osmotic pressure of the zinc sulphate in solution, the metal sends zinc ions into the solution. These ions bear positive charges of electricity and, consequently, the solution gradually becomes positively charged and the metal negatively charged, until the solution pressure of the zinc is exactly balanced by the osmotic pressure of the substances in solution. When this point is reached, the solution of the zinc ceases and no difference in potential exists between the metal and the liquid. It has just been shown that a variation in the concentration of the metallic salts in a solution surrounding a metal would cause a change in the potential difference existing between the solution and the metal.

In light of the preceding statements we can readily understand why we are able to obtain electrical current from two dissimilar metals or substances surrounded by an electrolyte.

Two metals, each having a different solution tension, will show, when immersed in a solution containing an electrolyte having an osmotic pressure comparatively low, certain positive differences in potential existing between the metals and the solution. The excess of the difference in potential existing between the metal with relatively high solution tension and the solution, over that electromotive force existing between the other metal and the solution, will be a measure of the resultant electromotive force tending to send current through the solution.

Such action may take place when the metals are in electrical contact and be either induced or not induced by external electrical forces. In either case, phenomena take place according to Faraday's Laws which may be expressed as follows:[1]

"1. The amount of chemical decomposition effected by the passage of the current is proportional to the amount of electricity which flows through the conductor.

"2. The amounts of the different elements which are separated by the same quantity of electricity bear the same relation to one another as the equivalents of these elements.

"3. The atoms of all equivalent elements carry exactly the same quantity of electricity, of bivalent elements twice as much, of trivalent three times as much, as so on."

Table II of electro-chemical equivalents will serve to explain more definitely the Laws of Faraday:

TABLE II.

Element.	Symbol, Atomic Weight.		Valence.	Chemical Equivalent—Atomic Weight Valence.
Hydrogen	H	1.008	1	1.008
Nitrogen	N‴	14.01	3	4.67
Oxygen	O″	16.0	2	8.00
Aluminum	Al‴	27.1	3	9.03
Magnesium	Mg″	24.36	2	12.18
Iron (ferric)	Fe‴	55.9	3	18.63

1. "Elements of Physical Chemistry," by H. C. Jones, p. 313.

Element.	Symbol. Atomic Weight.		Valence.	Chemical Equivalent—Atomic Weight Valence.
Tin	Sn''''	119.0	4	26.75
Iron (ferrous)	Fe''	55.9	2	27.95
Nickel	Ni''	58.7	2	29.35
Copper (cupric)	Cu''	63.6	2	31.80
Zinc	Zn''	65.4	2	32.70
Copper (cuprous)	Cu	63.6	1	63.6
Mercury (mercuric)	Hg''	203.3	2	100.15
Lead	Pb''	206.9	2	103.45
Silver	Ag	107.93	1	107.92
Mercury (mercurous)	Hg	203.3	1	203.3

The quantity of electricity required to deposit the chemical equivalent of hydrogen or silver in grams is exactly the same, namely, 96,530 coulombs. Thus we find that 96,530 coulombs of electricity, or a constant current of 10 amperes flowing for 9,653 seconds, or 2 hours, 40 minutes and 53 seconds, can liberate from their solutions 1,008 grams of hydrogen, 27.95 grams of ferrous iron, or 107.93 grams of silver.

The definitions and explanations which have been given under the head of "The Electrolytic Theory" are more or less essential in order that we may realize the innumerable factors which enter into the corrosion of iron when considered from the viewpoint provided by that theory.

It is not the purpose of this paper to go more deeply into the finer details of the electrolytic theory, as this would lead only to confusion, due to the fact that much exact experimental data concerning various types of corrosion must be obtained before certain deductions may be safely made. However, the foregoing definitions and explanations will serve to give a comprehensive view of the subject and, for all practical purposes, may be accepted as sufficient foundation upon which we may build our structure of the probable causes and possible preventatives of corrosion.

The foregoing explanations and definitions have placed us in a position where we no longer need deal with generalities, but may proceed with an application of the various statements in an explanation of the various kinds of corrosion of iron and steel.

The Corrosion of Iron According to the Electrolytic Theory.—One of the great laws of nature, with which we are all more or less familiar, is that of a tendency on the part of unstable conditions to reach a state of equilibrium. This applies to the electrolytic corrosion of iron as much as to other conditions involving opposed forces readjusting themselves to give stability.

Upon the surface of iron or steel we find a heterogeneous array of substances, such as metallic iron, several oxides of iron, graphite carbide of iron, alloys of iron with other metals, etc., and, consequently, substances of probably widely differing solution tensions which, when covered with water or with a film of moisture containing an electrolyte, show evidences of an unstable condition. The result is that those particles with the greater solution tensions go into solution as ions, while those substances which have lower solution tensions than the osmotic pressure of the electrolytes in the water probably receive positive charges of electricity from the metallic ions. Local electric currents are, therefore, set up, and these flow from the particles having higher potentials, through the electrolyte, to the bodies possessing lower potential.

We have just presumed that these particles exist upon the surface of iron or steel, which have different solution tensions, and, consequently, have varying differences of potential existing between the individual substances and the solution covering them. This presumption has experimental proof in the work of Wm. H. Walker and his associates.[1] These experimentalists found, by an ingenious method, the differences in potential existing between small areas of about ½ inch in diameter on the same polished surfaces of each of two separate sheets of metal used as culverts in road building. One culvert plate, which had given way, showed differences of potential ranging from +.047 volt to —.177 volt, while the best plate gave differences of from +.018 to —.005 volt. Allerton S. Cushman[2] has cleverly shown that manufactured articles of iron or steel have well defined electro-positive and electro-negative areas which often change positions, showing that a given area may alternately become positive and negative, depending on the nature of the particles exposed to a solution of an electrolyte. Homogeneity of a metallic surface is, therefore, essential to a minimum amount of corrosion.

1. "The Corrosion of Iron and Steel." Jour. Am. Chem. Soc.; Vol. 29; p. 1251.
2. "The Corrosion of Iron." U. S. Dept. of Agriculture, Office of Public Roads, Bulletin 30.

Factors other than those of a heterogeneous mass of substances may set up the differences in potential which are essential features of corrosion according to the electrolytic theory. Iron and steel under strain have been shown by C. F. Burgess[1] and others to have a greater solution tension than parts of the same materials in an unstrained condition. The same author tells us that some tests made by Mr. S. G. Engle and himself indicate that a heated surface of iron is electropositive as compared with the cooler piece of metal in the same solution. Dr. Hurmuzescu,[2] as a result of many investigations, found that iron, when magnetized as highly as possible, was positive to unmagnetized iron to the extent of .023 volt.

It can be readily seen that iron is subject to many diseases, any one of which may be sufficient to ultimately destroy its existence as a free metal. Whatever the nature of the disease, or the conditions producing the differences of potential, the electrolytic theory tells us that electrical currents are induced, and that these currents pass from the body of high potential, through a solution of an electrolyte, to a body of lower potential.

While, as a matter of fact, practically all corrosion is believed to be electrolytic in character, yet a distinction will be drawn between two types of diseases to which pipe is subject. It is only by the manner in which the electrical currents are induced that we will be able to differentiate between soil and electrolytic corrosion of iron pipe.

The Soil Corrosion of Iron.—Soil corrosion, as a matter of fact, is an electrolytic phenomenon, as is also ordinary atmospheric corrosion of iron structures. We have, in both cases, the essential factors of two or more particles of different solution tensions, in contact with each other, and surrounded or covered by an electrical conducting medium, such as gases, liquids or solids, dissolved in water. This medium may be large relative to the iron, or it may exist as an invisible film upon the surface of the metal. In soil corrosion the iron pipe is usually buried and surrounded by a soil containing much electrolytically inert matter, such as pieces of rock, pebbles, sand, etc., more or less saturated with water containing dissolved gases, such as carbon dioxide, sulphur dioxide, sulphuretted hydrogen, ammonia and similar compounds, and metallic salts, such as the chlorides, sulphates, carbonates and nitrates of sodium, potassium, calcium, magnesium and other metals.

The corrosion of iron pipe by soil waters may be best described by referring to Fig. 1, which is supposed to show a highly magnified sec-

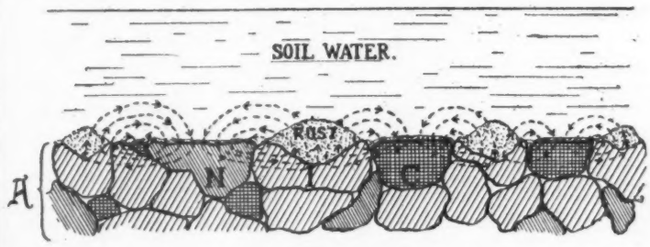


Fig. 1.

tion near the surface of the metal. For the sake of simplicity it is assumed that the soil water consists of a weak solution of sodium chloride (NaCl), and that the metal *A* consists of a mixture of particles of iron, nickel and carbon. The metals are electropositive to carbon, and the first named, iron, is electropositive to nickel.

In Fig. 1 an iron particle *I*, at the surface of the body of the metal *A*, is in contact on one side with a piece of nickel *N*, on the other with a fragment of carbon *C*, and on the upper surface with soil water which also covers the nickel and carbon. The iron particle *I*, being electropositive to the soil water and to the pieces *N* and *C*, is going into solution in the soil water and local electrical currents are set up, as shown by the arrows and dotted lines.

The iron in solution tends to travel with the electrical current and be deposited upon the particles of nickel and carbon. The sodium ions in the soil water also tend to be deposited in like manner, with the usual result of a secondary action between the sodium and water to form sodium hydroxide (NaOH) and hydrogen, which may cause polarization. The sodium hydroxide formed may diffuse and become ionized into sodium and hydroxyl ions. The latter hydroxyls may act as anions and migrate toward the iron particle *I*, where a combination between them and the iron ions results in the formation of

1. "The Corrosion of Iron from the Electrochemical Standpoint." Presidential Address. Amer. Electrochemical Society. April 30, 1908.
2. "Electromotive Force Developed Between Magnetized and Unmagnetized Iron." American Gas Light Journal, Aug. 26, 1901.

iron hydroxide or rust. The chlorine ions, of course, travel toward the iron particle *I*, and aid in its solution as a soluble iron chloride.

The rapidity of ordinary soil corrosion of any given iron pipe depends largely upon the electrolytes dissolved in the soil waters. Their concentration, as well as the nature of their products of decomposition when localized electrical currents pass through them, determine largely the rate at which the metallic iron will be corroded. For instance, the transformation of the free metallic iron into the ionic condition may depend largely upon the rate at which depolarization takes place. Thus, with oxygen or other depolarizing agents present in the soil waters, any cathodic areas covered with hydrogen would tend to be depolarized, with a resultant increase in local current flow and corrosion of iron particles.

The Corrosion of Iron by Electrolysis.—Electrolytic corrosion or electrolysis of iron pipe, as it will be considered in this paper, differs from soil or ordinary corrosion mainly in the manner by which the electrical currents are set up. In soil corrosion the electrical currents are purely local in character, due to differences of potential existing between the particles at the surface of the metal and the soil waters, while in electrolytic corrosion of iron pipe the currents are usually caused to flow from the pipe, through the soil waters, to some other conductor which, like the rest, is but a part of a circuit of some electrical system having its generating source at a distant point.

Electrolysis, as it has usually been termed, is the most serious type of corrosion with which we have to contend in the maintenance of underground metallic structures. The reason for this will be better understood by reference to Fig. 2, which endeavors to show the

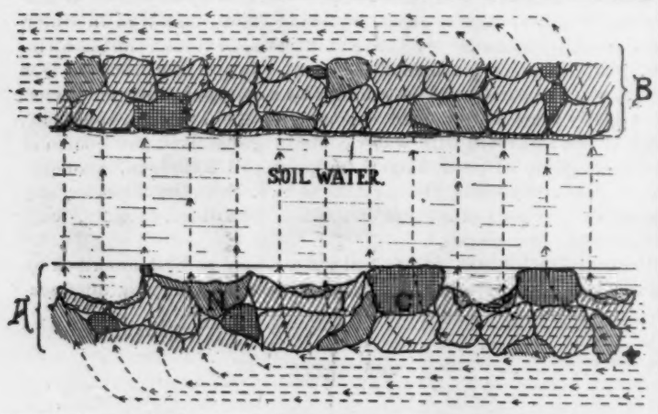


Fig. 2.

highly magnified section *A* of the iron pipe given in Fig. 1 undergoing electrolytic deterioration by an induced current flow from *A*, of positive potential, through the soil water, to a metallic conductor *B*.

As in the example considered under the subject of soil corrosion, the soil water may again be assumed to be a weak solution of sodium chloride (NaCl) and the section of metal *A* to consist, as before, of particles of iron, nickel and carbon. It should be remembered that the iron particle *I*, shown in Fig. 1, was electro-positive to the fragment *N* of nickel, and that the piece *I* was going into solution while *N* was not. In Fig. 2 we find that the induced potential of the metal body *A* has added its force to the natural solution pressures of the iron *I* and nickel *N*, with the result that both are going into solution with relatively greater rapidity. The carbon particle *C*, being strongly electro-negative to the solution and practically unaffected by the products of electrolysis, remains unchanged, but probably now delivers to, instead of receiving current from the soil water. Again, we find the iron and sodium ions traveling with the electrical current to find lodgment upon the body *B* instead of electro-negative particles on *A*. Nickel ions also travel with the electrical current toward *B*. The chlorine and the hydroxyl ions, which result from the dissociation of the sodium hydroxide (NtOH) formed by the action of deposited sodium on water, migrate to the pipe *A*, where the chlorine may act upon the water to give hydrochloric acid and oxygen, and where the hydroxyls and oxygen may result in the precipitation of dissolved iron as rust.

The fact that carbon or graphite particles, though serving as anodes, do not go into solution, may serve to explain the fact that cast iron pipes which have suffered from electrolysis, often retain their form and, to a great extent, their original appearance, although they can be cut with a penknife and are very light in weight. The explanation is a simple one. The graphite and other inert particles existing in cast iron form a skeleton around the voids left by the solution of the iron, until the spaces become filled with fine clay or earth that give solidity to the whole. Wrought iron and low carbon steel structures do not, as a rule, retain their original shapes when undergoing electrolysis, owing to the fact that their inert constituents do not exist in the same high percentages to be found in some cast iron bodies.

The fact that the amount of body *A* going into solution is, in many cases, practically proportional to the quantity of electricity passing between *A* and *B*, and that the quantities of electricity and electromotive forces involved in stray current conditions are usually much greater than the same factors in ordinary soil corrosion, readily accounts for the greater rapidity and extent of corrosion with which we have to contend in combating electrolysis of underground metallic structures.

In order to make this clear, let us consider for a moment the relative rates of soil and of electrolytic corrosion. While, of course, much depends upon the conditions, the following examples will serve to show the great disparity existing between the rate of corrosion by soil waters and by electrolysis. According to most authorities, uncoated wrought iron pipe, surrounded by soil waters resembling sea water, will corrode to a depth of about .5 inch in 100 years. Thus, the life of a 1-inch wrought iron pipe, having a wall ⅛ inch in thickness, would be approximately 25 years under such severe conditions.

In comparison with this, let us assume that there is a current flow of 10 amperes from a 1-inch wrought iron pipe having a wall ⅛ inch in thickness, into the soil waters. That the foregoing assumed value of 10 amperes is not excessive is readily seen when we learn from A. A. Knudson[1] that currents from 21.9 to 51.1 amperes were found leaving water pipes, and also note that E. E. Brownell,[2] in a report to the General Manager of the Laclede Gas Light Company, St. Louis, states that a condition was found where the pipes were as high as 12.5 volts positive to the rails, with a calculated current flow from pipes to rails of 625 amperes.

Upon the assumption that the 10 amperes flow, with a uniform current density from an area of 10 square feet of the outside surface of about 30 feet of 1-inch wrought iron pipe, we find, by calculation from data given in Table II., that 1 pound of ferrous iron may be put into solution by the passage of 1,566,585 coulombs of electricity, which is equivalent to a current of 10 amperes flowing for 43 hours, 3 minutes and 59 seconds. The assumption is, of course, that all the current flow is utilized in putting the metallic iron into solution. As 30 feet of 1-inch pipe would weigh about 50 pounds, 10 amperes would have to flow for about 2,153 hours, or 89 days and 17 hours, in order to duplicate the work of 25 years of ordinary corrosion by sea water.

The two examples given show us that the complete solution of a 1-inch wronght iron pipe may easily be 100 times more rapid by means of electrolysis than by ordinary soil corrosion. As a matter of fact, the current density is seldom if ever uniform, but usually high over small areas, and hence the corrosion by electrolysis where 10 amperes are leaving 30 feet of 1-inch wrought iron pipe would be much more rapid in certain spots and more destructive to the pipe's utility than that given in the foregoing example of ordinary corrosion by sea water.

Having considered the question of the corrosion of iron or steel according to the most advanced ideas upon the subject, we are now ready to take up a brief study of the various types of coatings and coverings, and of their several functions in the prevention of pipe deterioration by soil or electrolytic actions.

The Types and Functions of Coatings and Coverings.—The coatings and coverings which have been used as preventatives of corrosion of iron structures form a class consisting of as many different types of materials as we would be likely to find among any group of products intended for a specific use in the industrial world. They are so varied in character, application and efficiency that it is difficult for one to "separate the wheat from the chaff," and to place a comparative value upon each, or select the best preservative for metallic structures. The coatings designed for the prevention of iron corrosion have been classified in various ways by different authorities, but for the purposes of this paper the protective materials will be segregated according to their general physical and chemical characteristics.

1. "Electrolytic Corrosion of Water Pipes at Bayonne, N. J.;" A. A. Knudson, *Eng. News*, Nov. 17, 1904, p. 467.

2. "Electrolysis of Gas Mains." Milan B. Bump. AMERICAN GAS LIGHT JOURNAL, July 2, 1906.

Types.—Coatings and coverings might be divided into the following classes and sub-classes:

(1) Coatings of a liquid nature, consisting of one or more substances dissolved or mixed in one or more liquids of a volatile or oxidizable nature.

(a) Coatings which are applied cold by brushing, by spraying or by dipping the article to be covered, and harden by natural oxidation or combination of its constituents.

(b) Coatings which are applied cold or hot by brushing, by spraying or by dipping the article to be covered, and are usually hardened or dried by heating or baking.

(2) Coatings of a solid nature, consisting of organic compounds which must be melted before application to metal.

(a) Coatings which are applied by dipping articles to be covered in melted compounds and harden by cooling.

(b) Coatings which are applied by dipping articles to be covered in melted compounds and harden by cooling, oxidation, or combination of one or more of their constituents.

(3) Coatings consisting of inorganic compounds, such as alloys, oxides or silicates, fused or deposited upon metal.

(a) Coatings of metal applied by dipping in a molten bath or by electrolytic means.

(b) Coatings of oxides formed on or with the metal by various processes.

(c) Coatings of silicates formed on or with the metal by various processes.

(4) Coatings consisting of compounds used with wrapping materials or other substances.

(a) Coatings applied by wrapping with a material saturated with a compound.

(b) Coatings applied by incasing metal in mixtures of cement and other substances.

Class 1 embraces a large part of the paints used to prevent the corrosion of iron or steel. Naturally, most all of the so-called protective paints fall into this classification. We have mixtures of inorganic pigments, such as red and white lead, zinc oxide, iron oxide, numerous silicates, etc., with raw or boiled linseed and other oxidizable or volatile oils; mixtures of lampblack, graphite and similar pigments with oxidizable or volatile oils; mixtures or solutions of organic compounds, such as coal tar pitch, asphaltum, mineral pitch, rubber or wax with or in oxidizable oils, such as linseed, or volatile oils, such as naphtha, carbon disulphide or benzine; mixtures or solutions known as varnishes, consisting of gums or resins dissolved in oxidizable or volatile oils. Practically all liquid combinations of organic or inorganic compounds with liquids of a volatile or oxidizable nature, which might be hardened in a natural manner or by the application of heat, would fall into the first class.

Class 2 comprises most all of the so-called "dips." In this class would fall such compounds as pitches, obtained from the by-product tars in the making of coal or carburetted water gas, or from the distillation of oils; mineral rubbers or pitches, such as elaterite, gilsonite, etc., asphaltums, waxes and numerous other solid organic bases, pure or mixed with oils and other compounds, to give a solid material which must be melted before application to a metallic surface, where it can be hardened by cooling and oxidation or combination of its constituents.

Class 3 includes coatings or coverings such as zinc, applied or "galvanized" to the metallic iron in a molten or electrolytic bath, or any other metal or alloys; oxides of iron or of other metals formed on the surface of the article, similar to the formation of black oxide of iron by the Bower-Barff process, and all silicate and other coatings which are fused on, or made to combine with the iron itself by heating to a high temperature.

Class 4 embodies all coatings or coverings of classes 1 and 2 which are used in combination with some wrapping material such as cloth, glazed or unglazed paper, tar paper, special sheet material, and coatings or coverings of a bulky nature, such as concrete, or mixtures of organic bases with inert material of the nature of sand, pebbles or finely ground stone. Some coatings or coverings may be placed in more than one class subdivision, owing to the fact that they are susceptible to more than one method of application.

The foregoing classification will serve to show, for the present, the varied character of the compositions and methods of application of preservative paints, dips and coverings for iron and steel pipe.

(To be Continued.)

(Continued from page 483.)

The Glover and West Vertical Retorts at St. Helens.—Continuous Working with Gravity Charging.[1]

Some Miscellaneous Notes—Uniform Pressure and Other Conditions.—There is another noticeable feature about the working of these continuous retorts, and it is that in them the conditions may be said to go on from hour to hour and day to day with methodical consistency. The pressure gauges connected at the top and bottom of each retort indicate the uniformity of pressures as between the top and bottom of the retort and as between retort and retort. There is a little oscillation when the coke is removed from the hoppers below; but then it is observable that the pressures settle down again to normal almost instantly. Remember that such material as slack or washed nuts is being used in these retorts, and it will be admitted that, with such close lying material, to have level pressures at the top and only one-tenth difference at the bottom is an excellent condition of working. With such a small variation between top and bottom, there cannot be much difference in the pressure at the middle of the retorts. With loose material, the pressure, there is no question, would be about the same throughout the length of the retort.

There is an interesting point as to the condition of the charges in the retorts. Reference has been made to the facilities provided at the top of the retorts for testing by a rod the characteristics of the charges. Testing in this way, the formation of the charge appears to be composed of 2 to 3 feet of coke at the bottom of the retort, and then the uncarbonized portion seems to take a **V**-shape, with the spent portion of the charge on the outside. This being so, the travel of the gas must be through the colder or uncarbonized portion of the charge, and this is proved by the low temperature of the gas passing into the descension pipe at the head—viz., 160° C.

Another instructive feature is that in these eight 20 feet length retorts, 20 tons of material are carbonized per day. In the 8 retorts, there are 160 feet length; so that, given a production of 11,500 cubic feet per ton of local slack (in the use of which for gas making St. Helens appears to stand almost alone), the production is upwards of 1,400 cubic feet per foot-run of retort per day. If a Durham, or some other high-class, coal were used, the make per ton and per foot of retort would, of course, be considerably higher. It is understood, however, that arrangements will soon be made for carrying out tests in the vertical retorts on coals commonly used in other parts of the country, under the same exact conditions that the tests with the local slacks have been made. The results of these tests can be incorporated in a subsequent article.

A Thorough Testing, and a Fulfilled Stringent Stipulation.—As has been said, the contract for the setting was intrusted to West's Gas Improvement Company, Limited, of Manchester; but it was upon certain fixed conditions—the Corporation Gas Committee stipulating that the contractors should guarantee to improve upon the carbonizing results and labor costs of their existing retort house, and, failing this, that the whole of the plant was to be removed from the site without any payment whatever. When completed, the apparatus was for some time thoroughly tested by the contractors' engineers and chemists. They also obtained the services of independent operators to test the plant, and the results which were very satisfactory, were reported to the Gas Committee as follows:

Independent Experiments Made by Mr. J. E. Blundell, Chemist and Analyst, Southport, with Eight Vertical Retorts, 20 Feet Long, Continuously for 3 Days, Commencing March 10, Finishing March 13, 1909.

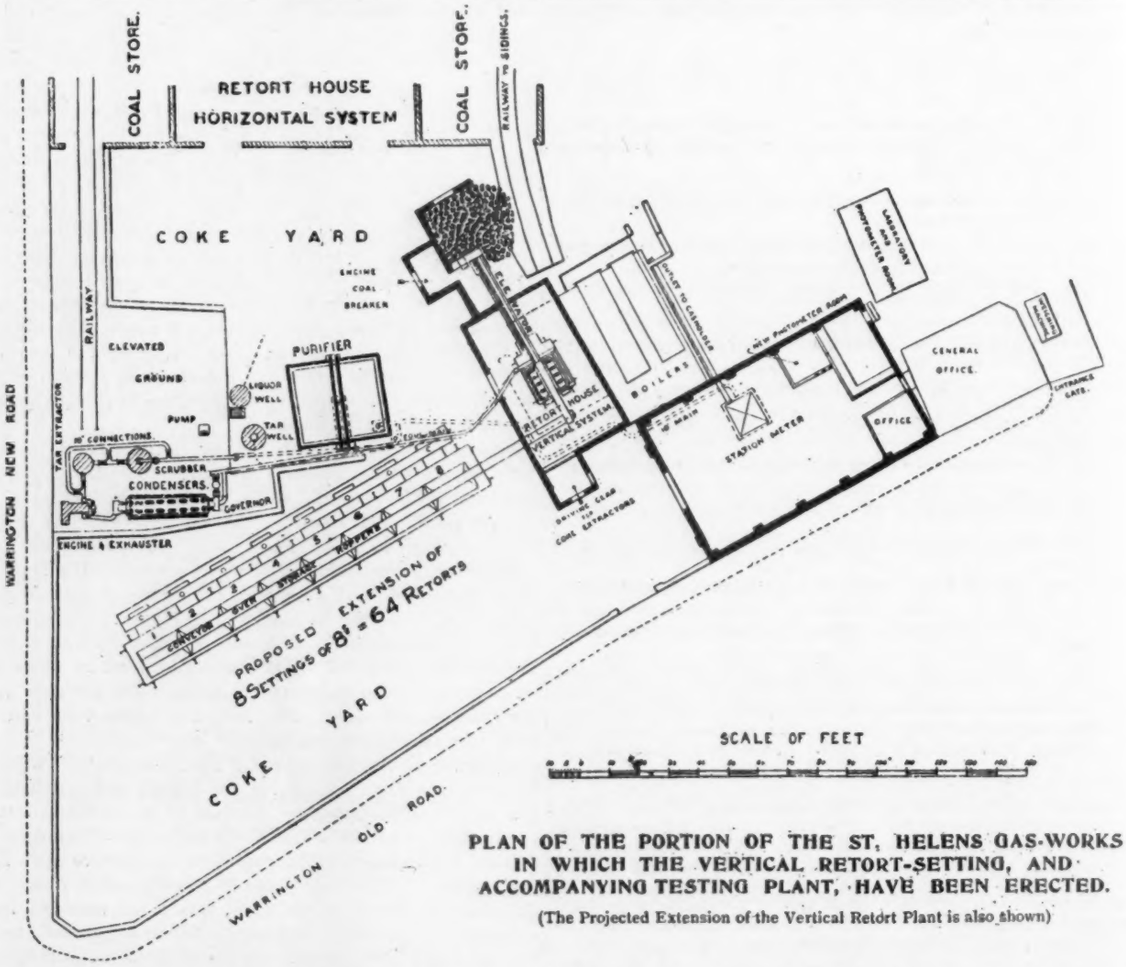
Coal carbonized, washed Orrell nuts (containing 5.35 per cent. of moisture, for which no allowance has been made.)	61 tons.
Total gas made (N. T. P.)	718,552 cubic feet.
Gas made per ton	11,779 "
Illuminating power	15.74 candles.
Calorific value, gross	600.25 B.T.U.
" " net	541.94 "
Tar per ton of coal	16 gallons.
Ammoniacal liquor per ton of coal	40.76 " 10 oz.
Sulphate of ammonia	34.33 pounds.
Coke per ton of coal	14.34 cwt.
Fuel, coke per 100 pounds coal carbonized	12.02 pounds.
Coal carbonized per retort (3 days' test) per 24 hours	2 t. 10 c. 3 q.
Gas made per retort (3 days' test) per 24 hours	29.939 cubic feet.
Yield of gas per foot length of retort per 24 hours.	1,496 "
Coal carbonized per retort (8 days following above experiment) per 24 hours	2 t. 11 c. 1 q.
Gas made per retort (8 days following above experiment) per 24 hours	30,710 cubic feet.
Yield of gas per foot length of retort per 24 hours.	1,535 "

Composition of Gas.

Carbon dioxide	2.0 per cent.
Unsaturated hydrocarbons	2.8 "
Oxygen	nil.
Carbon monoxide	7.2 "
Methane	33.57 "
Hydrogen	50.94 "
Nitrogen	3.49 "

Horizontal Retort House.—April 13, 1909.—A test was made with washed Orrell nuts of the same kind as used in the above experiment with the vertical retorts, with a view of ascertaining the difference in volume of gas obtained between each system of working—140 retorts 10 feet long were in use, with excellent heats, and these were

1. *Journal of Gas Lighting.*



PLAN OF THE PORTION OF THE ST. HELENS GAS-WORKS IN WHICH THE VERTICAL RETORT-SETTING, AND ACCOMPANYING TESTING PLANT, HAVE BEEN ERECTED.

(The Projected Extension of the Vertical Retort Plant is also shown)

charged with coal very evenly with West's manual machinery and most thoroughly burnt off—the results being as follows:

Coal carbonized (washed Orrell nuts).....	80 t. 2 c. 2 q.
Total gas made (N. T. P.).....	905,215 cubic feet.
Gas made per ton	10,510 "

Advantage of volume obtained in the verticals over the horizontals, per ton of coal carbonized, 1,269 cubic feet.

The bulk of the coals used at the St. Helens works are cheap washed and other slacks of the neighborhood, and these produce on the average about 10,000 cubic feet per ton; the gas being enriched with oil gas made by the Peebles process.

To make a comparison in the verticals, as against the above results obtained (upon the average) in the horizontals charged by machinery on April 19 to 22, 1909, two kinds of these cheap slacks, of which about 70 per cent. is used throughout the year, were tested—viz., 3 trucks of washed slack, 3 trucks of fine Arley slack mixed together; the results being as follows:

Total weight of coal carbonized.....	49 tons 6 cwt.
Total gas made.....	569,500 cubic feet.
Make of gas per ton of coal carbonized....	11,551 "
Average illuminating power.....	16.73 candles.
Average calorific value, gross.....	592.67 B.T.U.
" " " net.....	542.50 "

The coke produced in the verticals was of excellent quality, having a higher heating power, and the breeze from the coke is less than from the ordinary retorts.

The illuminating power for the horizontals could not be obtained, as the gas was enriched in transit to the station meter.

The illuminating power tests were made on the No. 2 "Metropolitan" burner.

The calorific value was taken with Junkers apparatus.

The whole of the plant and machinery worked in a most satisfactory manner without a hitch during the whole experiment.

(Signed) J. E. BLUNDELL, Chemist and Analyst.

The Corporation Gas Engineer (Mr. S. Glover) also reported that the working of the plant had been very satisfactory, and that excellent results had been achieved, and in the annual report of the Gas Committee, the following paragraph appears:

Durind the period under review, the new method of carbonizing coal in vertical retorts (which our engineer, in conjunction with West's Gas Improvement Company, has introduced by arrangement with the Committee) has been worked for a considerable time, and the Committee have taken great interest in the development of the new system, and have had it officially tested on behalf of the Corporation by a competent London expert, who has reported very favorably of the system and the way in which it is worked. This new system of setting retorts is likely to prove of particular value to the Gas Estate, as it is the only hope we have of being able to increase the production of gas at the old works, and our engineer is to be congratulated upon having taken another important step in advance.

It will be observed from this that the Gas Committee attached very considerable importance to the fulfilment of the guarantee, as the system was so great a departure from that in operation at their works. Hence the arrangement for an independent expert to thoroughly test the plant, in order to arrive at the full and complete measure of the value and advantages in every detail to be obtained by the adoption of the system. Their choice fell upon Mr. A. E. Broadberry, the Engineer of the Tottenham and Edmonton Gas Company (with a chemist) to make complete experiments with the plant. These experiments have been carried out, and Mr. Broadberry has reported that the whole of the guarantees imposed upon the contractors by the Corporation have been fulfilled, and that the results are superior to the working of the old system—the make of gas per ton of coal carbonized being increased considerably, more tar being produced of better quality, the coke also being of enhanced quality, while the cost for labor is materially reduced. The tests were made against the retort house, containing 24 beds of through retorts, operated by West's manual stoking machinery, so that the standard set (using the same class of coal) may be said to be a good one.

Results of Dr. Colman's Tests.—The patentees acted wisely in also placing the plant under the entire control of Dr. Colman for making

independent measurements and tests over several days' ordinary operation, and his results will be taken as unimpeachable in the matter of care and veracity. The coals used in these tests were washed nuts - similar to those tested in March by Mr. Blundell; the difference being that in Dr. Colman's test *the heats of the retorts were at a somewhat lower temperature.* After witnessing the working and the results, it is not by any means to be admitted that the returns secured by Dr. Colman exhaust the possibilities of the system—even using the class of coal that he employed.

CHEMICAL LABORATORY, 1, ARUNDEL STREET, STRAND, W. C., May 29, 1909.

DEAR SIRS—I beg herewith to present my report upon the test made with the installation of continuous vertical retorts at the St. Helens Corporation Gas Works, during a period extending over 4 days from May 20 to May 24.

Disposition of Plant.—The installation in question consists of a setting containing 8 vertical retorts, 20 feet in length, heated by gaseous firing from a generator combined with the plant. The gas produced is condensed and purified in plant which is entirely separate from that dealing with the gas from the horizontal retorts; the gas passing through a dry main to the foul main, thence through a set of vertical atmospheric condensers to the exhauster, after which it traverses successively a washer, scrubber and oxide purifier, passing thence to the meter, from which it mixes with the gas from the horizontal retort house.

Method of Carrying out the Test.—The coal used was weighed in the railway wagons over the Corporation machines, and elevated into the large overhead bunker common to all retorts. Between the latter and each retort a smaller bunker is fixed; each pair of small bunkers being separated from the large bunker by means of a slide-valve. At the commencement of the test, at 10 A.M. on May 20, matters were so arranged that the small bunkers were all full up to the level of the slide-valve, the large bunker being empty, and the same conditions were fulfilled at the close of the test at 10 A.M. on May 24, so that the ascertained weight of coal from the machine represented the actual quantity carbonized. In the same way, the generator was completely filled at the commencement of the test, and again at the end—the coke added in the interval being all weighed in. The clinker from the furnace was picked, and the unburnt coke returned to the generator unweighed.

The coke was dropped from the discharging devices into barrows at half-hourly intervals and weighed after standing for a short time.

Two tanks are provided for the tar and liquor. In the first, the tar and virgin liquor from the foul main and condenser collect; while the second contains liquor which is constantly circulated through the washer by means of a pump, and into which the scrubber liquor also runs. The first tank was emptied at the commencement of the test and the volume and strength of the liquor in the circulating tank ascertained. The tar and virgin liquor obtained in the first tank during the test were measured and sampled, and the increase of volume and strength of circulating liquor at the end of the test determined and included in the ammonia production—account being also taken of the tar deposited in the second tank; this having been separated by the action of the washer. In addition, the amount of ammonia in the gas leaving the scrubbers was determined and allowed for.

The dry purification was effected by oxide of iron only, and no air was admitted for revivification during the test.

RESULTS OBTAINED DURING TEST, MAY 20-24, 1909.

Coal Carbonized.—The coal carbonized consisted of washed Orrell nuts, containing the following quantities of moisture and ash, as determined from an average sample collected from the various trucks used as they were unloaded:

Moisture	3.95 per cent.
Ash	6.94 "

The total weight carbonized during the 96 hours of the test amounted to 74 tons 14 cwt.

Gas Made.—The total quantity of gas produced during the period amounted to 855,236 cubic feet, corrected to 60° Fahr., 30 inches barometer.

Yield of gas per ton	11,448	cubic feet.
" " " diem	213,800	"
" " " retort per diem	26,725	"
" " " foot length of retort per diem	1,336	"

Quality of Gas.—As the gas made from the vertical retorts mixed with the gas from the horizontal retorts before the holders, separate arrangements were necessary to obtain an average sample of the gas, and the existence of a holder of some 1,000 cubic feet capacity, in connection with the test plant of the Corporation, enabled this to be done in a satisfactory manner—a stream of the gas as made being led into this holder over considerable periods, and the collected gas then used for the determination of the illuminating and the calorific power.

The illuminating power was ascertained on the bar photometer using the Harcourt 10-candle pentane standard and the "Metropolitan" No. 2 burner. The calorific power was determined by means of the Junkers calorimeter. Eight samples in all were collected; the period of collection being 11 hours, except in the first instance—the gas being sampled therefore for 85 out of the 96 hours the test was in progress. The results obtained were as follows:

No.	Sample Collected.	Ill. Power. Candles.	Calorific Power. B.T.U. Gross.	Calorific Power. B.T.U. Net.
(1)	May 20, 12:30 P.M. to May 20, 8:30 P.M.	16.85	592.0	534.7
(2)	" 20, 9:30 " " 21, " "	15.83	591.0	526.4
(3)	" 21, " " " 21, " "	16.86	594.0	542.9
(4)	" 21, " " " 22, " "	16.06	580.4	525.8
(5)	" 22, " " " 22, " "	16.02	580.4	520.0
(6)	" 22, " " " 23, " "	16.19	589.4	527.2
(7)	" 23, " " " 23, " "	16.46	584.0	524.5
(8)	" 23, " " " 24, " "	15.94	593.5	534.9
	Average	16.28	588.8	529.6

Composition of Gas.—Samples of Nos. 3, 4 and 6 were taken, and subjected to complete analysis, with the following results:

	No. 3.	No. 4.	No. 6.	Average, Per Cent.
Carbonic acid	2.1	1.8	2.0	1.97
Unsaturated hydrocarbons	2.7	2.8	2.6	2.70
Oxygen	Nil	Nil	Nil	Nil
Carbonic oxide	9.9	10.0	9.8	9.90
Methane	32.4	31.2	32.3	31.97
Hydrogen	49.7	51.3	51.0	50.67
Nitrogen	3.0	3.1	2.1	2.73
	99.8	100.2	99.8	99.94

Production of Coke.—The total weight of coke produced during the test was 55.34 tons, weighed moist. An analysis of an average sample collected from each barrow as weighed gave the following results:

Moisture	4.0 per cent.
Ash	10.8 "

Therefore the yield of coke moist as weighed equalled 14.8 cwt. per ton; yield of dry coke equalled 14.2 cwt. per ton.

Generator Fuel.—The total weight of moist coke used in the generator was 9 tons 8 cwt.; and therefore;

Fuel used equalled 12.56 per cent. of moist coke.
" " " 12.06 " " dry "

Yield of Tar.—The total yield of tar, free from liquor, was 1,302 gallons, equalling 17.2 gallons per ton.

Quality of Tar.—The tar produced was thin and uniform in consistency, and contained 5 per cent. of water as sampled. Much of this water readily separates on standing, and under ordinary works' conditions of the tar remaining for some time in the wells, this amount would doubtless be decidedly lower.

The analysis of the tar (free from liquor) gave the following figures (specific gravity at 60° = 1.076):

Composition of Tar by Distillation, Etc.

	Per Cent. By Volume.	Per Cent. By Weight.
Light oils up to 170° C	3.8	3.0
Middle oils, 170° to 270° C	29.6	27.0
Heavy oils, 270° to 350° C	24.7	23.8
Pitch, above 350° C	....	45.9
Naphthalene	....	4.5
Free carbon	....	2.5

Yield of Ammonia.—The total yield of ammonia, calculated at 10-ounce liquor, amounted to 2,960 gallons:

Equalling 39.6 gallons of 10-ounce liquor per ton.
" 33.4 pounds of sulphate of ammonia per ton.

Yield of Cyanide.—A test of the gas made at the inlet to the washer showed the following:

Cry. sod. ferrocyanide	4.8 pounds per 10,000 cubic feet.
$Na_4FeCy_6 10 H_2O$	5.5 pounds per ton.

The quantity of cyanide is therefore quite equal to, or better than, the average obtained from the horizontal retorts.

Sulphur in Gas after Purification with Oxide Only.—A test of the

total quantity of sulphur in the gas after purification showed 37.5 grains per 100 cubic feet.

During the whole period of the test, matters proceeded with the utmost regularity, the continuous introduction of the coal into the top of the retorts, and the removal of the coke from the bottom, taking place with great smoothness. [Signed] HAROLD G. COLMAN.

The Advantages Summarized.—To sum up, the experience derived from the working of the system has so far indicated that the following advantages are obtained by its use:

(1) Increased make of gas per ton of coal carbonized.
(2) Increased yield of tar per ton of coal carbonized.
(3) Increased production of ammonia per ton of coal carbonized.
(4) Coke improved and of more value.
(5) No stopped ascension or descension pipes.
(6) Increased make of gas per retort.
(7) Largely increased make of gas on same ground space.
(8) Improved labor conditions, and at considerably reduced cost.
(9) Great economy and saving in first cost of land and buildings.
(10) Reduced wear and tear on retorts.

Future Extensions.—Owing to the saving in space that can be effected with vertical retorts, the system will enable a large extension of the carbonizing plant to be made within the boundary of the land now belonging to the Gas Estate. An additional machine charged horizontal retort house would be out of the question; and the present retort house, with horizontal retorts charged and discharged by West's manual machinery, cannot be extended. If the plan is referred to, a projected extension on the vertical system will be seen. The site represents the little remaining property, within the public roads surrounding the works, belonging to the gas department. This is now occupied by the old plunge baths of the town and other buildings. But it will be sufficient to enable an extension of the carbonizing plant to be made on the vertical system, and thus the necessity of going to another site (already secured) will be deferred, as well as the consequent large expenditure. The extension of the verticals contemplates 8 settings of 8's, and, as the present setting is regularly dealing with 20 tons a day of local slack, the new bench would represent an additional carbonizing capacity of 160 tons of the same class of coal.

It only remains to congratulate Messrs. Glover and West on the success that has attended their efforts at producing a simple combination for the continuous carbonization of coals in vertical retorts, and West's Gas Improvement Company on the manner in which they have carried out this first installation of 8 retorts on the system. Needless to say there has been a great amount of anxiety on their part as to the success of the venture, in view of the conditions attaching to the contract. Had failure to come up to the guarantees been the result of their enterprise, the financial loss would, of course, have been very considerable. Fortunately, the end has been the one desired, and there is no doubt that the personal interest Mr. West, Sr., has, in conjunction with Mr. Glover, taken in the development of each detail has had much to do with the success of the complete system, of which it has been our privilege to make such minute examination.

Laying a Subaqueous Reinforced Concrete Pipe with Cast Iron Flange Connection.

According to *Engineering News*, at the Marion, N. J., plant of the Public Service Corporation of New Jersey, there have been recently installed two large concrete suction pipes, which are provided with an elbow and which were each laid in two parts bolted together at a cast iron bange molded into the concrete coincident with the molding of the pipe. At the time the enlargement of the power house was projected the merits of various metal and concrete pipes were investigated, and it was decided to use the Lock-Joint pipe, a reinforced concrete pipe which has been described in our columns. December 10, 1908, p. 643. This pipe is made up of a series of short lengths of concrete pipe, reinforced with wire cloth or expanded metal. Each length is provided with special bell and spigot ends, which leave a circumferential opening in the inside of the pipe to be filled with concrete after the lengths are joined together.

The suction pipes at the Marion plant had to be laid from the intake at the river back through a dock and bulkhead to meet a wrought iron pipe at the wall of the power house. It was thought necessary to put the bottom of the pipe 7 feet 6 inches below low water, so that there might always be a free flow of the full capacity of the pipe to the wells and, in order to get only clean water, the outer end of the pipe was made in the form of a down-turned elbow. The distance from the intake to the house pipe was about 40 feet.

Excavation was started in the mud in front of the dock and, by taking up the floor, under the dock, where it was found that a large oil pipe running parallel to the bulkhead line, obstructed the free laying of a 40-foot length of pipe. It was then decided to put the concrete pipe down in two sections and join them with a bolted cast iron flange. Excavation was then continued under the obstructing pipe and a pile and timber cradle driven in line on which to rest the pipe.

The pipe itself is shown in Fig. 1. It is 54 inches in inside diameter

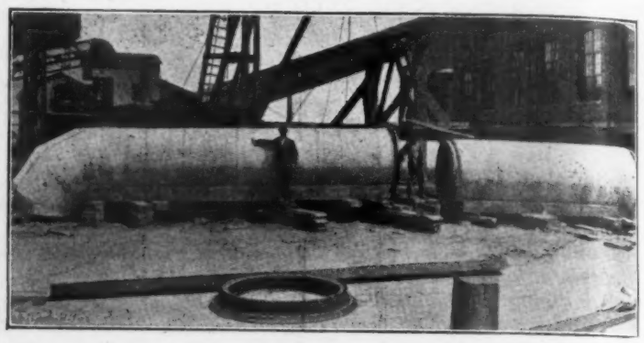


Fig. 1.—Two Sections of Lock-Joint Reinforced Concrete Pipe Before Placing as Suction Pipes.

with a shell thickness of 5½ inches reinforced with triangular mesh wire cloth. The long section is made up of six 4-foot lengths with a 6-foot elbow and the short one of four 4-foot lengths. All the joints in these two sections, including those in the elbow (which is in three pieces and is extra reinforced) were made according to the special inside filled groove joint of the Lock-Joint Pipe Company. (See right-hand side Fig. 2.) Each section was made and joined on the dock,

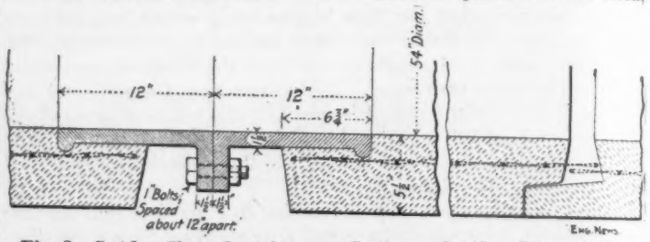


Fig. 2.—Cast Iron Flange for Subaqueous Continuous Reinforced Concrete Pipe.

through which it was dropped into position. The detail of the flange connecting the two parts is shown in Fig. 2. It is merely an L-section circumferential plate of cast iron, placed in the molds at the time of concreting and firmly held in place by the concrete which was set around it. The bolt holes in the flange are about 12 inches c. to c.

Ten days after the short lengths had been jointed, the pipe was lowered onto the cradle. First the 16-foot length was lowered at an angle and slid underneath the cross pipe. When this length rested in a horizontal position on the cradle the 24-foot length was lowered directly through the hole in the wharf to its position, flange against flange of the other length. Divers assisted the placing of these two lengths and saw that the bolt holes of the flanges lined up and then bolted them together. Not only was the connection of the two concrete pipes provided with this bolted flange, but a similar one was placed on the shore end of the 16-foot section, to which the flange of the wrought iron power house pipe was bolted.

Two suction pipes of the type and dimensions described were placed immediately alongside one another. They are now in position and are working very efficiently with no perceptible leakage.

The design of the pipe is due to Mr. Coleman Meriwether, of the Lock-Joint Pipe Company, New York. The work was carried on under the direction of Mr. J. T. Whittlesey, Chief Engineer of the Public Service Corporation of New Jersey, by the F. M. Stillman Company, contractors.

The Significance of Drafts in Boiler Operation.

A bulletin issued some weeks ago by the United States Geological Survey is a comprehensive study of the draft question in connection with the steam boilers. It refers chiefly to the conditions in power boiler operation, particularly where forced or induced mechanical draft is employed to accelerate the rates of combustion. Most of the bulletin covers a study of the losses in air pressure in the passage through the furnace and the boiler proper, and the laws are investigated and developed in connection with a series of experiments with beds of shot to stimulate the effect of fuel. It is evident that the bulletin aims to discuss the question from the ground up, and some of the explanations, particularly those referring to the elements of the

draft question, such as are given below, are of somewhat of an elementary character, but none the less valuable on that account, as giving a means for elucidating a subject none too well understood. The following has been selected from the bulletin, which is No. 367, by Walter T. Ray and Henry Kreisinger, as interesting to those identified with the heating business:

The Word Draft Defined.—In the steam boiler furnace the hot fuel is made to burn by passing a current of air through it. This current of air supplies the necessary oxygen and carries away the gaseous products of combustion. In order that the boiler may absorb the heat generated by combustion and contained in the gases leaving the fuel bed, the gases are caused to flow along the heating plates of the boiler and to impart heat to them by coming into contact with their surfaces. The stronger the current of air through the fuel bed the higher the rate of combustion, and, likewise, the stronger the current of gases over the heating surfaces the faster the boiler seems to absorb heat. It is thus evident that the motion of the air and of the gases of combustion is very essential to the operation of a furnace and boiler. The motion of gases is produced by an excess of pressure at any point over that at any other point toward which the gases are flowing; the greater the pressure difference the higher the velocity of flow. The word "draft" is loosely applied sometimes to the motion of gases and sometimes to the difference of pressure producing the motion.

The use of high chimneys is most common. They reduce the pressures inside their bases so that the greater pressure of the atmosphere outside pushes air through the fuel bed and gases of combustion through the boilers into their bases. The reduction of pressures is due to the fact that gases expand when heated, in consequence of which the chimneys contain smaller weights of gases than they would if chimneys and gases were cold. We then have the weight of a column of hot gases in the chimney pressing against the gases in the uptake, and the weight of a column of air of the same dimensions and at atmospheric temperature pressing against the air in the ashpit.

It is evident that the hotter the gases in the chimney the more they are expanded and the lighter they are, and the greater is the difference of gas pressure between the front of the furnace and the base of the chimney; also that the higher the chimney the greater is the difference in pressure. Anything which reduces the temperature of the gases while in the stack reduces the magnitude of the pressure difference between the chimney base and the furnace doors; on this account less coal can be burned and less steam made. It follows that a steel stack without any brick lining on the inside is, on account of the high thermal conductivity of the steel, not as efficient as a brick one, provided the latter is absolutely tight, as is seldom or never the case.

The drop of gas pressure from one part of the boiler setting to another varies as some power of the resistance to the flow of gases. Thus a great drop from ashpit to furnace indicates a high resistance in the fuel bed, and a great drop from the furnace to the uptake indicates a high resistance to the flow of gases through the boiler proper.

Experiments with Length of Boiler Tubes.—In a forthcoming bulletin on heat transmission into boilers, now nearly finished by the present authors, are given data from about 250 tests on small laboratory multitubular boilers fed with air heated electrically. Some interesting results from two boilers of 10 tubes each are given in the accompanying table. The longer tubes absorbed about 10 per cent. more of the heat available to them from each pound of air than did the shorter ones, and only about 8 per cent. less air passed through them, under the same pressure drop. Therefore, the longer tubes actually absorbed as much heat total as did the shorter ones, from less air.

Taking as 100 per cent. the weight of air passing through the shorter tubes, the 92 per cent. of air passing through the longer ones is higher than one might expect.

Tests from Two Laboratory Multitubular Boilers Fed with Air Heated Electrically.

	Boiler No. 1.	Boiler No. 2.
Internal diameter of tubes, inches	0.175	0.175
Length of tubes, inches	8.28	16.125
Air passing through boilers per second under a pressure drop of 10 inches of water at an initial temperature of 700° F., pounds	0.0096	0.0088
Five inches of water at an initial temperature of 700° F., pounds	0.0073	0.0067

Resistance of Grate and Fuel Bed.—The resistance which the fuel bed offers to the flow of air varies with the thickness of the fire, the size of the coal and probably with the moisture of the coal and the nature and quantity of ash on the grate. The resistance of the grate is constant and should be small, because the energy required to move air through it is uselessly expended. It follows that the percentage of air spaces in the grate should be as high as mechanical construction and factor of safety allow. The pressure drop of air through the grate should be as nearly zero as possible.

A pressure ("draft") gauge connected to the space above the fuel bed gives useful information as to the condition of the fire to a fireman who understands the significance of its indications. Thus, after cleaning a fire, if the pressure drop from ashpit to fuel bed is too small the fireman may be sure that there are holes in the fire, or that it is too thin; or, if the pressure drop is too great, it is probable that the fire is too thick. A gradual increase of the drop through the fuel bed, after a fire has burned for some time (in case of hand firing especially), is an indication of the accumulation of clinker next the grate.

Finally, as the fundamental idea of draft, it may be stated that "with gases there is no pulling, only pushing." Gases travel from places of higher pressure to those of lower, the motion of the gas occurring because of its expansion.

Electric Furnaces in Germany.

Recent United States Consular Reports on this subject are: Hitherto electric furnaces in Germany were used chiefly for the treatment of small quantities, but now the leading works are beginning to employ them on an extensive scale for handling large quantities of metal. At the close of 1907 one of the most important steel works in the Empire engaged in the production of cast steel for gears, as well as of the softer varieties of malleable cast steel for automobile construction and for minor machine parts, decided to replace its battery of crucible furnaces by a large electric fusion furnace. The main cause for the change was the desire to materially lessen the cost of fusion, while not lowering the quality of the steel, but, on the contrary, improving it, if possible.

The old equipment consisted of 32 furnaces, each containing 6 crucibles with a capacity of 77 pounds. They are replaced by a single electric furnace of 250-horse power, capable of holding a charge of a metric ton (2,205 pounds). A duplicate furnace is likewise installed and kept as a reserve for emergencies.

Electricity is supplied from the large works of a company near Cologne, which furnishes a 3 phase current of 5,200 volts to quite a large territory near the Rhine for both power and illumination. Alterations in the current intensity are so slight that connection is made directly, without the interposition of a regulator, between the furnace and the transforming station. At the latter a 3-phase rotatory current, reduced to a tension of 110 volts, is supplied.

Production of Cast Steel.—The production of cast steel in this furnace has been carried on since the beginning of 1908 without interruption, and with such a degree of success that the results are well worthy the attention of American steel manufacturers Details of the cost and process generally are herewith reproduced in some fulness, on account of the far reaching importance of this revolution in the central feature of one of the leading industries of the United States.

The main product of the furnace has been cast steel, containing about .06 per cent. phosphorus, .03 per cent. sulphur, and from .08 to .18 per cent. carbon. Occasionally charges of tool steel have been cast, containing from .7 to 1.3 per cent. of carbon, with and without the addition of nickel, chromium or tungsten. The material employed is ordinarily slugs, cuttings, turnings, and other waste of wrought iron, costing from $14.28 to $15.47 per metric ton (2,205 pounds), $12.96 to $14.04 per short ton. A fusion, including the refining, lasts about 5 hours and involves a consumption of about 900 kilowatt hours for 1 metric ton of cast steel. The entire charge of 1 ton is poured at once. When the furnace is kept in continual use the magnesite lining lasts for about 70 operations, *i. e.*, 20 to 25 days. A stoppage of 5 days is required for each renewal, but during this period the reserve furnace is employed.

The cost of the electric current is exceedingly low, on account of the large amounts consumed. It amounts to 4½ pfennigs (1.071 cents) per kilowatt hour, so that the expense for a single operation is about 40 marks or $8.64 per short ton.

The total cost of cast steel, thus produced, per metric ton is as follows:

For	Cost.
Amortization of cost of plant	$1.19
Raw materials, including additions, chromium, etc	16.66
Electric current, including heating during intervals	10.71
Renewal of magnesite lining	2.85
Labor	2.38
Electrodes	0.60
Water for cooling purposes	0.12
Total	$34.51

This amounts to $31.32 per short ton, and is materially less than the cost of crucible steel.

Advantages of the Electric Process.—The manufacturing firm notes in addition these advantages in the electric process, as compared with the old method: (1) Cheaper raw material can be employed in the place of the more expensive Swedish iron formerly required; (2) in fusing quantities of a ton at a time it is possible to produce homogeneous masses of a distinct, well-defined grade; (3) the molten steel leaves the furnace at a much higher temperature than when prepared in crucibles, is therefore in a more liquid condition, and is easily transferred to ordinary ladles, preparatory to pouring into the molds of small castings.

These electric furnaces are arranged on the Stassano system, and are supplied in all sizes, for charges varying from 400 pounds to 10 tons, and are adapted for the fusion of metals of every kind.

The furnace for cast steel is constructed of iron plates, heavily lined with magnesite bricks. Carbon electrodes enter by three openings on the sides, and are so adjusted as to terminate slightly above the surface of the molten metal, whereby the heat of the arc is absorbed almost entirely by the contents of the furnace, and but a small portion is radiated upward to be reflected from the concave dome.

Mixing and Fusion—Other Uses.—A thorough mixing of the component parts of a charge is effected by mounting the furnace on an axis, slightly inclined from the vertical. A steady revolution about this axis is maintained through a cogged connection, with a dynamo of 5-horse power, the edge of the furnace resting on ball bearings. This rotation causes the lower layers to gradually rise to the top of the molten mass, and brings about a thoroughly uniform mixing. The electrode supports are inclosed in cylinders and surrounded by a current of cold water. These supports are in rigid connection with hydraulic cylinders, by means of which the movements of the electrodes are under perfect control.

A fusion requires 3½ hours to be complete; a further period of 1½ hours is requisite for the removal in succession of phosphorus and sulphur, and the final deoxidation of the contents of the furnace. No interruption occurs in either the current of electricity, or in the supply of water for cooling the electrode supports, while the furnace is in rotation. Special devices have been provided for both purposes.

The services of 3 workmen are required to conduct an electrical furnace, change electrodes, transport the raw materials, etc. Furnaces of the type in question are now being introduced in Germany for the treatment of other metals and alloys, and it is apparently only a question of time before the crucible processes hitherto in such general use will be completely superseded.

Latest British Wiring Rules.

The *Elec. World* notes that, unlike the United States, Great Britain does not possess an underwriters' wiring code that is applicable to all cities in the kingdom, or equivalent to the National Electrical Code of this country. The Phœnix rules are the most widely used, however, and approach more nearly those used here. These rules have just been revised and the main points of interest in them are given herewith so that a comparison with American rules may be made. The latter rules are used extensively in Canada. In some instances the Phœnix rules are at variance with the wiring rules of the Institution of Electrical Engineers. Warning is given in the introductory note in regard to the necessity of exercising care in accepting a tender for wiring, and intending users are recommended to retain advising engineers to design and supervise the erection of an installation.

The conductivity of copper conductors must not be below 98 per cent. of that of pure copper, as defined by the Engineering Standards Committee (instead of 100 per cent., according to Matthiessen's standard). Current density is still to be taken at 1,000 amp. per square inch, up to currents of 100 amp., and no change is made in the minimum size of conductors. The standard of insulation for conductors to be used in damp places or in new buildings, and also for pressures between 250 and 500 volts, is to be 2,500 megohms per mile (formerly 2,000 megohms).

Additional regulations on conduit work are as follows: All piping should be erected before any conductors are drawn in. All joints in piping should be treated with aluminum paint. The use of T-pieces and elbows is not recommended; plain junction boxes should be used throughout. No single pipe must contain more than 4 wires. Open seam piping with socket connections is not recommended, and is only allowed for surface work and where the pressure does not exceed 250 volts.

Wood casing will be allowed in dry positions only. Wiring joints are only allowed in casing where unavoidable (in the old regulations permission was necessary).

Lead covered wiring is now allowed, but it must be protected where it is liable to mechanical injury or chemical action. The lead covering must be grounded, and where alternating currents are used both lead and return conductors must be in the same lead tube or covering. Systems with unguarded return are now allowed after permission has been obtained.

Flexible wires and cords must not be joined to hard wiring, except by means of screw connections in a fireproof junction box. The insulation of flexible cords must consist of two coats (minimum thickness of each 10 mils) of pure Para rubber of high quality, or of one coat of pure Para rubber of high quality next the copper and two coats of vulcanizing rubber (the minimum radial thickness of rubber must be a total of 40 mils). Flexible cords not provided with an efficient flameproof outer covering must not be used in shop windows containing inflammable goods.

Surface systems of flexible twin wiring will only be allowed in situations where the wires will not be liable to mechanical injury or damp, chemical action, etc. The systems must be carried out to the approval of the Fire Office.

Ground wire must never be of less section than No. 14 S.W.G. (No. 12 B & S). It is recommended that one end of the grounding wire should be soldered to an approved ground connection and the other end attached to the case of the main switchboard or other iron-cased apparatus by means of a detachable screw lug.

Cotton mills and certain other mills are now included with hazardous risks as situations where, if arc lamps are allowed to be used, they must (unless of inverted type) have two globes, each completely and independently surrounding the arc, and the lamps should be of such design and make that the arc cannot be sustained unless the inner globe remains intact. The inlet holes for wires of portable lamps must be bushed. Flexible twin wires used in connection must be substantially insulated. The use of switch lampholders is not recommended. Where allowed they should be grouped and switch-controlled.

Where main switchboards are in connection with a system of iron or steel conduit it should be inclosed in a cast iron case and glazed front. Where it is in connection with a wood casing or unprotected system, inclosing cases made of hardwood will be allowed. Distribution fuseboards must be of the same general construction as for main switchboards, and must be inclosed as for main boards. (This would imply a cast iron case where tubing systems are employed.)

Lamp switches, 2-way switches, etc., must be of approved type, and of not less than 5-amp. capacity, and inclosed in fireproof boxes, the covers of which must be insulated.

The term "fuses" has replaced that of "cut-outs." A 50-per cent. overload (except under certain circumstances when a larger amount allowed) is still specified for fuses, but the minimum break is now 2 inches (1 inch was formerly allowed for 100 volts pressure). The distributing circuits from fuseboards must not carry more than 8 amp. at 25 volts, 6 amp. at 50 volts, 5 amp. at 100 volts and 3 amp. at 200 to 250 volts. Magnetic cut-outs and circuit-breakers must be of approved type.

The rules on dynamos and motors have been entirely rewritten. The maximum temperature of the dynamo at full load must not exceed 70° F. above the surrounding atmosphere. The rules for motors are:

Motors must be inclosed in substantial metal cases, which may form part of the construction of the motor; any openings in the case for ventilating purposes must be covered with metal grids. Slip rings of induction motors must be totally inclosed in metal cases, wherever they are exposed to the liability of mechanical injury or access of dust or damp, etc. Motors must not be placed in positions where they may be exposed to mechanical injury, extreme damp or dust, unless suitably inclosed to prevent mechanical injury, ingress of dust or fluff, or possibility of injury from excess of damp. In risks where inflammable dust or vapor is present the motor must be inclosed in a

substantial metal case without ventilating apertures, the pulley being external to the case. The case may be connected by suitably inclosed ducts or pipes to the outside air. All adjacent woodwork, both vertical and horizontal, must be efficiently protected with fireproof material. Wood floors, on which motors are fixed, must be lined with a sheet of metal.

Each motor must be protected by a switch and a fuse, or its equivalent, in each connecting lead. In specially exempted cases, such as a traveling crane, or a tool with one or two motors, then one switch to control the whole will be allowed. Each motor should be on a separate circuit. Each motor should be furnished with an approved automatic no-voltage and overload release. The frames of motors and all metal piping and metal-cased apparatus in connection must be efficiently connected to earth.

The temperature rise of motors under normal working conditions must not exceed 70° F. above the surrounding atmosphere as measured by a thermometer, provided the total temperature does not exceed 140° F. The terminals of motors should be so constructed as to insure that they are efficiently protected by metal covers or an equivalent device. In positions where motors are liable to collect dust, etc., and a totally inclosed motor is not required, the motor should be cleaned periodically by means of a small compressor or hand bellows. Excessive depreciation and trouble are found to occur through neglect in keeping the interior of the motors clean and free from dust.

Auto-transformers must be of sufficient capacity to stand an overload of 25 per cent. for short periods. The transformers must be totally inclosed in strong cast iron cases with removable lids. Terminals to be within the iron cases and the leading-in holes for cables fitted with bushes, except when metal pipes are screwed direct into the case. The metal cases and frames of transformers must be grounded.

The transformer rules have now been reduced to only a small fraction of their former length.

Supply mains should be carried in iron conduit and the apparatus in connection should be inclosed in substantial iron cases.

No telephone wire should be of less section than No. 20 S.W.G. (No. 19 B & S), and the insulation of the circuit inside a building should never drop below 1 megohm. A high voltage fuse also must be placed upon each telephone wire.

All electric radiators should be fixed to, or stand upon, approved fireproof insulators. A wire guard should protect the radiator lamps. Every floor socket should be so constructed that the contacts are automatically covered when the plug is removed. Electrically heated flatirons and smaller apparatus should each have double fuses and a switch, and be independently grounded.

Notes on Warming and Ventilation.

The *Journal of Gas Lighting* notes that at a recent meeting of the English Surveyors' Institution a paper on the named subject was read by Mr. E. H. Blake, in the course of which the author pointed out that in the year 1619 James I. proclaimed against the then general overhanging storeys of houses, and ordered the walls of new buildings to be carried straight up; and 12 years later his successor Charles I. went further, proclaiming the heights of rooms and proportions of windows for the "benefit of ventilation." The continued crowding, however, accompanied by the filthiest of surroundings, caused the carrying off of about 100,000 persons by the plague; while the great fire of London in 1666, which was a "blessing in disguise," did more for the public health in 3 or 4 days than hundreds of years of proclamation. New buildings were put up in which crude attempts at sanitation were introduced by Inigo Jones and others; rooms were made larger and loftier, and stairs and passages lighter; fireplaces were put into nearly every room, cellar dwellings were discontinued, streets were paved and drained—in fact, the whole aspect of things was vastly improved according to the best ideas of the time.

Unfortunately, however, continued the author, we still find, in spite of our increased appreciation of sanitary construction, buildings almost as ill-planned and ill-ventilated as those of 200 or 300 years ago. Much has been done by legislation in the provision of sufficient air space around buildings, the prevention of overcrowding, and so forth; and much more can yet be done by legislation in the way of the more skilful planning of towns. But the necessity for ventilation remains. The science of ventilation is closely allied to that of warming, and the two processes are often combined. It will be convenient to deal with the latter first, since rooms are rarely without some means of warming, even though there be no ventilation.

The modern methods of warming consist of open fires, close fires or stoves, hot water, steam, hot air and electricity. The first mention of "iron grates for burning coal" is found in inventories early in the sixteenth century; and at its end Sir Hugh Platt diminished the depth and width of the hearth recess, and contracted the mouth of the flue. A French architect—Savot—about the year 1624 introduced the perforated base plate of the ordinary grate, and much reduced the height and width of the fireplace opening. At the beginning of the nineteenth century, Count Rumford, the founder of the Royal Institution, did more to improve the fireplace than anyone up to that time. He brought the firegrate forward, set the mantel lower, emphasized the importance of forming a "throat" to the flue and bringing it well down over the fire, and introduced the diverging sides or covings, to obtain greater radiation of the heat into the room.

Later in the century, valuable experimental work was done in connection with the improvement of fireplaces by Dr. Teale, F.R.S., who embodied his conclusions in a paper, read in 1886 before the Royal Institution, on "The Economy of Fuel in House Fires." The chief conclusion obtained by Dr. Teale was that slow and efficient combustion depends on there being no current of air up through the grate; and he accordingly introduced what is known as the "economizer," shutting in the space below the grate. He also laid down a series of rules for the design of fireplaces, the principal of which are: (1) Use as little iron as possible, making both back and sides of firebrick; (2) the firebrick back should lean over the fire—the idea of this being suggested by Rumford but developed by Dr. Teale; and (3) the greatest efficiency is obtained from the covings when they are inclined at an angle of 60° to one another.

Gas fires are generally considered unsatisfactory, though many improvements have been made to them in recent years. They are apt to cause want of humidity in the air, or at any rate to produce a parched feeling in the throat. There is a great prejudice against the use of close fires or stoves; people say they want to see the fire. Such stoves are apt to get very hot, and they then roast and burn the floating particles of animal and vegetable matter in the air, and give off unpleasant odors. They are liable to decompose the air, and they certainly deprive it of much of its moisture. A close stove also cannot, as a rule, be looked upon as any aid to ventilation like an open fire.

For the warming of buildings by hot water there are two systems available—the low pressure and high pressure, respectively. The former method is by far the older, having been introduced about the beginning of the eighteenth century by a Norwegian gentleman for the purpose of warming a greenhouse. The system was introduced into England by the Marquis de Chabannes, who added the storage cylinder, which he usually placed under the stairs. The water circulated by reason of the heavy cold water descending and forcing the lighter warmer water up. As carried out nowadays, low pressure hot water warming is both economical and satisfactory, except for the large diameter of pipe used—usually 3 to 4 inches. The pipes are not sealed as in the case of a high pressure installation.

The high pressure system was invented early in the nineteenth century by a Mr. Perkins, and was known by his name for some time. It consisted of an endless pipe, part being coiled in a furnace and radiating coils being put where needed. The method of installiug it has varied but little since its introduction. The advantages of the system are that the pipes, being smaller than those used in the low pressure system, are less unsightly, and the water can be sooner heated. On the other hand, the disadvantages are the very high pressure in the pipes, the unequal diffusion of heat (generally due to defective circulation caused by bends, etc.), and the fact that the system requires skilled attention and is liable to scorch the air.

Heating by steam was suggested as far back as the sixteenth century. The "Philosophical Transactions" of the eighteenth century contain particulars of many proposed methods of steam heating, all of which are very imperfect and dangerous, and it was not till the opening of the nineteenth century that a workable system was installed on very much the same lines as those at present adopted. There are both high and low pressure systems. A steam heating installation has a life of about 25 years; but a hot water installation is practically indestructible and costs far less for maintenance. The advantages claimed for a steam installation are: (1) There is less liability of damage by frost than in the case of hot water pipes; (2) smaller radiators can be used; and (3) rooms can be more quickly warmed and cooled. On the other hand, any form of heating by steam needs skilled attentton and close supervision. It has also the disadvantage of scorching the air and depriving it of much of its moisture.

In recent years electricity has become more popular as a means of warming; but it is an expensive method. The best form of electric radiator is that containing long bulb lamps. The filament is heated to an orange red, in which state it gives out most heat. The glass cases of the lamps are frosted or ground, to enable them to retain some heat rays and so assist in warming the air by convection. The use of radiators involves the necessity of duplicate systems of wiring

the building, so that the current consumed may be charged on the "power" scale. The system is not so cheap as fires, but is far cleaner, more sanitary, under perfect control and portable. As to cost, a 4-lamp radiator consumes one Board of Trade unit per hour at a cost of from 2 to 4 cents per unit, or ½ cent to 1 cent per lamp per hour.

Passing on to deal with the other section of his paper, the author remarked that there are few subjects in a more unsatisfactory state than that of ventilation, or the removal and dilution of the products of combustion and respiration. A large amount of experimental work has been done in recent years; but the problem seems still far from solution. The principal impurities found in the air of rooms are organic matter and carbonic acid gas. The former cannot be accurately or easily estimated, but it is known to be a fairly constant ratio to the latter, which is therefore made the basis of a standard of purity. The proportion of carbonic acid gas in the air of a room should not exceed 0.6 cubic foot in 1,000 cubic feet of air. The ordinary air of towns contains about 0.4 cubic foot in 1,000; and the average adult is said to give off about 0.6 cubic foot of the gas an hour. At this rate, he will in 20 minutes raise to the allowable limit of impurity 1,000 cubic feet of air, and so should be provided with about 3,000 cubic feet of air per hour. This is often put in another way, to the effect that he should be given 1,000 cubic feet of space, and the air be changed three times an hour. It is not wise to put it this way, as the change of air is more important than the space occupied; and it has been shown that apartments with a large cubic space per head and slow change of air are less healthy than those with less space and more frequent change. In calculating the quantity of air required, each gas jet or candle can be regarded as equal to one human being in its effect on the purity of the air. In calculating the cubic space, no height above 12 feet should be taken into account.

The essentials of a satisfactory method of ventilation and warming may be summarized thus: (1) Fresh air must be admitted or injected, and the vitiated air allowed to escape, be extracted or expelled. (2) The quantity of air supplied and the velocity of admission to be under control. (3) The change of air to be thorough; no stagnant corners being left. (4) No draughts to be caused. (5) The incoming air to be clean and humid, and not scorched or deprived of its moisture by defective methods of warming it before admission. (6) The temperature to be uniform and under control. In the author's opinion, there is no system at present which absolutely fulfils these conditions at all times; but he described briefly those in use, and stated their various advantages and disadvantages.

Methods of ventilation can be classified in various ways; for example, there are both upward and downward systems. It is essential that the vitiated air should be extracted while warm, as the carbonic acid gas, when cooled, is heavier than air, and falls to the floor to be re-breathed. Air, as it becomes warm and vitiated, tends to rise, and the air currents from the body also tend upward. This is an assistance to upward, but an obstacle to downward ventilation; necessitating in the latter case the introduction of about three times as much air as is needed, in order to dilute the vitiated air that is sent down to be re-breathed. Gas jets, etc., assist upward, but are difficult to deal with in downward systems. The latter are also difficult to work satisfactorily in halls having galleries.

Systems of ventilation can be classified as natural and artificial; the two being combined. In a natural system, inlets are provided through which the fresh air enters without assistance, and outlets through which the vitiated air will escape without it. The objections to the system are that the source of supply of fresh air is not under control; the incoming air is not so readily cleansed and humidified; the volume, temperature and velocity of the incoming air are not under control; and it is a draughty system. On the other hand, it is simple and inexpensive, costing very little for maintenance; and doors and windows may be quite freely opened without disorganizing the system. The simplest form of artificial or mechanical ventilation is that in which the inlets are as already described; the outlets being assisted as extractors by gas jets, steam or water jets, hot water or steam coils, electric radiators, or other means of increasing the current through the outlet. Other forms provide for both propulsion and extraction by mechanical means.

Having described in considerable detail the "Plenum" system of ventilation, and given some particulars of another mechanical system, of a distinctly different character, recently introduced by Dr. Glover Lyon, for which many advantages are claimed, the author concluded by explaining that, though there are innumerable patents connected with ventilation, his notes were only intended to treat of the broad principles involved in the more important systems. He added that in testing the ventilation of any building, one could not do better than follow the advice of Dr. Parkes: (1) Find the amount of cubic space and floor space per person; (2) find the number of cubic feet of air per person per hour; and (3) test the air by the senses, and by chemical, mechanical and biological methods. In comparing costs, it was necessary to capitalize the outlay on maintenance, and add it to the initial cost, as the system which seemed the more economical might possibly be the more expensive.

Items of Interest
FROM VARIOUS LOCALITIES.

"W.," WRITING from Superior, Wis., under recent date, says: "At the annual meeting of the Superior Water, Light and Power Company, the officers elected were: Directors, C. A. Chase, Kenneth Clark, R. B. Dunn, W. R. Merriam, F. A. Ross, V. M. Watkins, P. G. Stratton, Thos. B. Scott and W. H. Winslow; President, W. R. Merriam; Vice-President, Robt. R. Dunn; Treasurer, V. M. Watkins; Secretary and General Manager, W. H. Winslow."

"R.," WRITING from St. Louis, under date of the 7th inst., says: "The many friends of Mr. David Coleman, of St. Louis, an experienced gas retort bench setter and as such known to many American gas superintendents, will greatly regret to learn of his death, which occurred the 3d inst. Mr. Coleman had an experience in the gas bench construction that covered a great many years, and his personality made him many friends during his temporary sojourns at different gas works where his vocation called him. His former employers speak of him in the highest terms regarding his sterling qualities and unfailing attention to his duties."

AT the annual meeting of the Kalamazoo (Mich.) Gas Company a large representation of the shareholders voted. The position of Second Vice-President was created by resolution, and Mr. F. W. Blowers was elected thereto. He was succeeded as Secretary by Mr. Elliott W. Shaw. The complete executive staff is: Directors, F. W. Blowers, J. J. Knight, H. D. Walbridge, Ira A. Ransom, J. W. Thompson, Edward Woodbury, Chas. A. Peck, H. B. Coleman and Dr. H. B. Osborn; President, H. D. Walbridge; First Vice-President, J. J. Knight; Second Vice-President and General Manager, F. W. Blowers; Secretary, Elliott W. Shaw; Treasurer, H. G. Edwards; Assistant Secretary and Treasurer, H. S. Brown.

THE Danville (Ills.) Street Railway and Light Company this year appropriated the sum of $85,000 to be used in bettering its gas plant division, which means an increased generating capacity and all that goes therewith. Another important addition is a storage holder up to retaining 200,000 cubic feet. A large sum also went into main extensions, the plans for which provided for the placing of 12 miles thereof. This addition to the main system will certainly increase the sendout by not less than 25 per cent.

CAPITALISTS hailing from Lincoln, Neb., have applied to the authorities of Havelock, Neb., for a franchise under which they propose to construct a gas plant in that center, and from it supplying the adjacent settlements of Bethany and University Place. It is thought that the main interest in this project is connected with the Lincoln (Neb.) Company.

THE various soup-kitchen, ice-fund journals of this city are seemingly much exercised over the final disposition of the monies unclaimed from the custody of Commissioner Shields in the matter of the New York city gas rebate fund, which money will likely go into the hundreds-of-thousands. Judging from the plaints in the Hearst variety of paper the money should go to the great not-counted out, while if one were swayed by the slush put forth by the Pulitzer specials that family should be allowed to advertise the unclaimed sums, until the bills for advertising it should equal it. However, there is a clever, cool, capable gentleman, in the person of Commissioner Shields, in charge of the fund, and he will be guided by the law as laid down by the Judges. While the new watchdogs were baying or howling, the Commissioner went before Judge Lacombe who issued the following instructions for the guidance of the Commissioner:

"The money is to be turned over to the Gas Companies, they to give bond to settle with whatever claimants may appear.

"All repayments will be subject to deductions of any amount claimant may be in arrears to the Company.

"The Gas Companies shall execute a bond, conditioned that every consumer or his lawful executors, administrators or assigns, may hereafter present to them a claim for repayment of overcharges represented in this fund, within the proper period, fixed by the statutes of the State, prompt payment thereof shall be made; provided, that should the Companies be satisfied that the claimant is for any reason not entitled to the sums claimed it shall submit the controversy with him to this court to be summarily disposed of without cost to such claimant, if successful. And that in the event of the court's summarily deciding that the money is rightfully due to said claimant the Company will promptly pay the sum to him.

"That it will in like manner pay the various claims now in controversy before the Special Master, or in which the necessary papers are being perfected, promptly upon receipt of directions from the court as to whom payment should be made.

"The unclaimed balance thus ordered to be transferred is principal only. It was stated in the memorandum, filed February 18, that the expense of administration might well prove to be so great as practically to exhaust accumulations of interest. Besides a large number of assignments which have had to be investigated, and the many attempts to defraud which have been detected and punished, the work of auditing the claims of individual consumers and drawing the checks to pay them have been expenses."

MR. CARROLL MILLER, of Pittsburgh, Pa., has been retained as Constructing Engineer by the Providence (R. I.) Gas Company during

the construction of the new plant at the latter place. This will necessitate his withdrawal from the general field of consulting engineering.

It is said that the distributing system of the Bessemer (Ala.) Gas Company will be extended to the outlying settlements of Brighton and Jonesboro. Manager Henry Fishbrook is well satisfied over the way gas mantles are going in that busy Alabama mart.

A correspondent in Springfield, Mass., writing under date of the 3d inst., forwards the following, which originally appeared a day or so earlier in the Springfield *Republican*: "The Springfield Gas Light Company will begin the construction of a new building on State street, near the corner of Water street, about September 1. The ground floor will be finished off as a general office and the second floor will contain quarters for the various officers of the Company. The building will be in the French Renaissance style of red brick with white stone facings, and it will harmonize with the Nayasset Club building. The sides and rear will be almost entirely of brick. The ground floor will have a large space in the middle lighted from above. There will be a large appliance room in the rear of the building and behind the working space. The floor will be of marble mosaic or tile, and the ornamental work will be treated simply in plaster. The offices on the second floor will all open on the well, which is over the main office on the first floor. This will be lighted by a skylight in the room. In addition to offices for the President, Secretary, Treasurer and Directors, there will be a room for the bookkeepers and draftsmen, and several toilet rooms. There will also be an up-to-date laboratory on the second floor for the use of the chemical department in carrying on the various experiments that are a part of the manufacture of gas. The main floor will be entirely taken up by the office and the large central space. The store of the Company will remain at its present location, but all the other departments will be moved to the new building as soon as it is completed. The building, which will be 81 feet 6 inches long and 62 feet 6 inches wide, will be located in the empty lot adjoining the present works office of the Company. The latter will not be disturbed, but will continue to be the headquarters of the manufacturing end of the business. The new building will be placed back from the sidewalk about 12 feet and will be surrounded on all sides by grass. The building will be ready for occupancy the 1st of April next, as on that date the Company will have to vacate its present offices. The architects are Winslow, Bigelow & Wadsworth, of Boston."

Mr. J. W. Peffley, Sales' Agent for the George M. Clark Company, informs us that the Eastern storeroom and agency have been removed from 356 Fourth avenue to 1493-1505 Broadway, New York.

We are officially informed that the city of Raton, New Mexico, with a population of not less than 8,000, is to have a works, of the coal gas type, that is to be constructed and operated by local capitalists. The plans and specifications therefor are being prepared by Mr. Henry I. Lee, "The Rookery," Chicago, who will be glad to answer all inquiries on the subject.

The gas plant proposed for Saranac Village, N. Y., is now under construction by the Public Utilities Company, of Philadelphia, Pa., the headquarters of which concern are in the Girard Trust Company's building in that city. The contract for the water gas apparatus and the purifiers has been awarded to the Gas Machinery Company, of Cleveland.

A correspondent in St. Louis, writing under date of the 9th inst., says: "One of the most interesting events that will happen in connection with the Detroit meeting of the American Gas Institute, will be the opportunity afforded of witnessing the operation of the stack of inclined benches which the Detroit and Suburban Gas Company is installing; in fact, which benches are rapidly nearing completion. These inclines are being built according to the most modern methods of bench construction, in that they are of the full-depth recuperative type, equipped with evaporators and extended generators. A feature of this installation is the simplicity of the coal handling and charging apparatus. Surprising results are expected from this installation, and no doubt the latter will prove interesting to the visiting gas men, particularly as the benches are of strictly American design and are being built strictly with American material. Since this construction was started, the increasing demands made upon the Gas Company to take care of its new business, necessitated the adding of an additional bench to the original order; and, from present indications, it looks that this whole installation will have to be duplicated in a very short period. The installing of the apparatus noted above has been intrusted to the care of the Gas Bench Construction Company, of St. Louis."

Superintendent W. H. Williams, of the Kenebec (Me.) Light and Heat, Company is quite well satisfied with the progress that is being made on running the connecting main between Hallowell and Gardner. He is quite certain the lines will be joined by the 1st prox., even though some pretty stiff drifting remains to be done.

At the annual meeting of the shareholders in the New Bedford (Mass.) Gas and Edison Light Company, Treasurer Price's reports showed that the Company was in excellent financial shape and that every interest of the Corporation was advancing. He noted that, on account of the reduction in the price of gas from 90 to 85 cents per 1,000, and in the rate for electricity from 15 cents to 14 cents, with a sliding scale, the gross returns were not quite as large as those of the preceding twelvemonth. However, the output had increased most satisfactorily, the gas output showing an increase of 20 per cent., and the electric division showed a gain of 17 per cent., as between the last twelvemonth and its predecessor. The experiment of extending the gas mains to the district of Lund's Corners was attended with good success, and it was further advised that other pipe extensions be made next year. The officers elected were: Directors, Frank H. Gifford, Thos. Knowles, P. M. Lund, H. G. Howland, L. B. Bates, H. M. Knowles, Geo. R. Stetson, Jno. S. Perry, Fred. Taber and Oliver Prescott, Jr.; Treasurer and Clerk, Chas. R. Price.

The Plymouth (Mass.) County Gas and Power Company has asked the Selectmen for their consent to an extension of its mains to and through the town of Randolph.

The Massachusetts Board of Gas and Electric Light Commissioners, in accordance with the act passed by the last Legislature authorizing the Commissioners to determine the proper amounts of sulphur and ammonia that may be permitted to remain in gas supplied to consumers, has decided that these shall be the permissible maximum amounts: Sulphur, 30 grains per 100 cubic feet; ammonia, 10 grains per 100 cubic feet.

Formal transfer of the properties of the Los Angeles (Cal.) Gas and Electric Company and those of the Pasadena (Cal.) Consolidated Gas Company, to the Los Angeles Gas and Electric Corporation, was recorded some days ago.

A correspondent in Los Angeles, Cal., writing under date of the 5th inst., incloses the following, which rather goes to show that Judge Monroe must be a very matter-of-fact man. The narrative is: "Because members of a jury in Judge Moore's court played with an electric torch while discussing the merits of a damage suit against the Los Angeles Gas and Electric Company, Judge Monroe last week made an order granting that corporation a new trial in the suit brought against it by Thomas Higgins, owner of the ground upon which was located the old Cressatty restaurant, which was the site of an extensive explosion the evening of 13th February, 1907. Flashlights were employed by the inspectors of the Gas Company when they were examining the Cressatty premises for a leak in the gas pipes. Plaintiff claimed that the explosion had been caused by the use, not only of these searchlights, but aided by striking matches which ignited the floating gas. In connection with this testimony the torches were passed to the jurors in the box, and when the jury retired to deliberate its members took the torches with them. And information leaked out afterwards that the jurymen had toyed with the flashes in the jury room. Judge Monroe held that it was an error to permit the jurors 'to play' with the flashes or to take the device with them into the jury room. The verdict turned in by the first trial jury awarded plaintiff damages in the sum of $8,159.72."

"W. L. T.," writing from Boston under date of the 9th inst., says that Superintendent of Streets Emerson had closed arrangements with the Rising Sun Lighting Company under which that Company will continue to furnish the street lighting as at present carried on until Feburary 1, prox. The Company agreed to reduce the rate per lamp to $23.60, or a concession of $1.36 per lamp, from the price under the unexpired contract. The Superintendent was forced to this alternative in that the Board of Aldermen refused to allow him the money necessary to purchase the lamps and mantles to carry out the work altogether on city account.

The Doherty syndicate evidently means to carry on its usual level headed policy in connection with its recent purchase of the franchises and plant of the Spokane Falls (Wash.) Gas Company. As an earnest of this intent it may be said that maps of the streets are being prepared as guides to main extensions that are to be made forthwith. To show the scale on which the additions are to be made it is only necessary to state that the first provision will call for the placing of 15 miles, no diameter of pipe to be less than 4 inches. How's that for common sense liberality.

Mr. Arthur M. Cantril has resigned the position of Manager of the Pueblo (Cal.) Gas and Fuel Company in order to take charge of the management of the Spokane (Wash.) Gas Company. His successor at Pueblo will be Mr. Henry D. Frueauff, Secretary of the Pueblo Company. This is speedy promotion; but Mr. Cantril well merits it.

Mr. Van Tyne Pritchard, Box 535, Dodge City, Kas., is desirous of corresponding with manufacturers of gas apparatus.

The Frankfort and Lebanon (Ind.) offices of the named artificial Gas Companies have been consolidated, with headquarters in the former place. Mr. J. C. Stewart who has been in charge at Lebanon will assume charge at Frankfort. He succeeds Mr. Thomas B. Frazer, who has been promoted to the Lafayette office.

The bench work on the new generating house of the Columbus (Ind.) Gas Company will be done by the Laclede-Christy Company, of St. Louis, and the scrubbing and condensing apparatus will be furnished by the Lloyd Construction Company, of Detroit.

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MONDAY, AUGUST 16, 1909.

The Market for Gas Securities.

The market for city gas shares was fairly animated last week, and the trading was done in the main at advancing figures. The opening to-day (Friday) came in at 147 to 147¼, and inquiry for the shares was frequent, quite more frequent than has been chronicled of late. Our prediction of 175 for it before the end of September is still good.

Brooklyn Union is 148 to 149, and almost everyone interested in gas shares in this vicinity is looking for another spectacular dividend payment. However, the Company's business of itself is sufficient to account for a good, sharp rise in it. Peoples, of Chicago, is 117 bid, and Washington gas is 364 to 368.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

AUGUST 16.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies,	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated Gas Co.	$78,177,000	100	147	147¼
Central Union Gas Co.—				
1st 5's, due 1927, J. & J.	3,000,000	1,000	98	101
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	2,500,000	100	155	165
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	100	101½
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	100	101
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	104	107
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	94	100
Standard	5,000,000	100	—	75
Preferred	5,000,000	100	70	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	148	149
1st Con. 5's, due 1948, M. & N.	15,000,000	—	91½	92
Yonkers	299,650	500	120	—
Out-of Town Companies.				
Bay State	50,000,000	50	1¼	1
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	500,000	1,000	90	98
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	73	73½
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,000,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	20,500,000	100	92	93
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90½	91
Preferred	3,026,500	100	75½	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	105
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	885,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	458,000	—	102	105
Detroit City Gas Co	5,000,000	50	—	50
" Prior Lien 5's	4,619,000	1,000	97	100½
Detroit Gas Co., 5's	881,000	1,000	75	80
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	112	113½
" Bonds, 5's	10,500,000	—	103	103½
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis	10,000,000	100	104	105
Preferred	2,500,000	100	—	98
Bonds	10,000,000	1,000	104	—
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,370,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	350,000	1,000	106	108½
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	65½	66
Preferred	25,000,000	100	91	91¼
Montreal Gas Co., Canada	2,000,000	100	218	218½
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	117	117¼
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104½	105½
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	751,000	1,000	100	102
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	90	95
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	100	104
Washington (D. C.) Gas Co.	2,600,000	20	363½	367½
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	220	—

Advertisers' Index.

GAS ENGINEERS.

Bartlett-Hayward Co., Baltimore, Md. 513
Cruse-Kemper Co., Philadelphia, Pa. 500
Davis & Farnum Mfg. Co., Waltham, Mass. 512
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Evens & Howard Firebrick Co., St. Louis, Mo. 498
Frank D. Moses, Trenton, N. J. 494
Frederick J. Mayer, New York City 493
Henry I. Lea, Chicago, Ills. 512
H. M. Byllesby & Co., Chicago, Ills. 513
Humphreys & Glasgow, New York City 512
Improved Equipment Company, New York City 494
Isbell-Porter Co., Newark, N. J. 500
Kerr Murray Mfg. Co., Fort Wayne, Ind. 513
Laclede-Christy Clay Products Co., St. Louis, Mo. 508
Parker Russell Mining and Mfg. Co., St. Louis, Mo. 497
Quintard Iron Works, New York City 501
R. D. Wood & Co., Philadelphia, Pa. 514
The Gas Machinery Co., Cleveland, O. 492
The Stacey Mfg. Co., Cincinnati, O. 515
The United Gas Improvement Co., Philadelphia, Pa. 507
Western Gas Construction Co., Fort Wayne, Ind. 520
William A. Baehr, Chicago, Ills. 490

GAS WORKS APPARATUS AND CONSTRUCTION.

Bartlett-Hayward Co., Baltimore, Md. 513
Chamber Oven Co., Milwaukee, Wis. 495
Connelly Iron Sponge & Governor Co., New York City. 509
Continental Iron Works, Brooklyn, N. Y. 510
Cruse-Kemper Co., Philadelphia, Pa. 500
Davis & Farnum Mfg. Co., Waltham, Mass. 512
Deily & Fowler Mfg. Co., Philadelphia, Pa. 516
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Evens & Howard Firebrick Co., St. Louis, Mo. 498
Gas Engineering Co., Trenton, N. J. 494
Humphreys & Glasgow, New York City 512
Improved Equipment Company, New York City 494
Isbell-Porter Co., New York City 500
Kerr Murray Mfg. Co., Fort Wayne, Ind. 513
Laclede-Christy Clay Products Co., St. Louis, Mo. 508
Lloyd Construction Co., Detroit, Mich. 502
Quintard Iron Works Co., New York City 501
R. D. Wood & Co., Philadelphia, Pa. 514
Riter-Conley Mfg. Co., Pittsburgh, Pa. 499
The Gas Machinery Co., Cleveland, O. 492
The Stacey Mfg. Co., Cincinnati, O. 515
The United Gas Improvement Co., Philadelphia, Pa. 507
Western Gas Construction Co., Fort Wayne, Ind. 520

PROCESSES.

Bartlett-Hayward Co., Baltimore, Md. 513
Chamber Oven Co., Milwaukee, Wis. 495
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Humphreys & Glasgow, New York City 512
Improved Equipment Company, New York City 494
The Gas Machinery Co., Cleveland, O. 492
The United Gas Improvement Co., Philadelphia, Pa. 507
Western Gas Construction Co., Fort Wayne, Ind. 520

SCRUBBERS AND CONDENSERS.

Bartlett-Hayward Co., Baltimore, Md. 513
Continental Iron Works, Brooklyn, N. Y. 510
Cruse-Kemper Co., Philadelphia, Pa. 500
Davis & Farnum Mfg. Co., Waltham, Mass. 512
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Evens & Howard Firebrick Co., St. Louis, Mo. 498
Isbell-Porter Co., Newark, N. J. 500
Kerr Murray Mfg. Co., Fort Wayne, Ind. 513
Quintard Iron Works, New York City 501
R. D. Wood & Co., Philadelphia, Pa. 514
Riter-Conley Mfg. Co., Pittsburgh, Pa. 499
The Gas Machinery Co., Cleveland, O. 492
The Stacey Mfg. Co., Cincinnati, O. 515
The United Gas Improvement Co., Philadelphia, Pa. 507
Western Gas Construction Co., Fort Wayne, Ind. 520

PRODUCER POWER PLANTS.

Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
R. D. Wood & Co., Philadelphia, Pa. 514

TAR AND CARBONIC ACID EXTRACTOR.

Bartlett-Hayward Co., Baltimore, Md. 513
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Isbell-Porter Co., Newark, N. J. 500
Kerr Murray Mfg. Co., Fort Wayne, Ind. 513
The Gas Machinery Co., Cleveland, O. 492
The Stacey Mfg. Co., Cincinnati, O. 515
The United Gas Improvement Co., Philadelphia, Pa. 507
Western Gas Construction Co., Fort Wayne, Ind. 520

AMMONIA CONCENTRATORS.

Bartlett-Hayward Co., Baltimore, Md. 513
Michigan Ammonia Works, Detroit, Mich. 490
The Gas Machinery Co., Cleveland, O. 492
Western Gas Construction Co., Fort Wayne, Ind. 520

GAS METERS.

American Meter Co., New York and Philadelphia. 519
D. McDonald & Co., Albany, N. Y. 517
Helme & McIlhenny, Philadelphia, Pa. 519
John J. Griffin & Co., Philadelphia, Pa. 472
Keystone Meter Co., Royersford, Pa. 518
Maryland Meter and Mfg. Co., Baltimore, Md. 518
Metric Metal Co., Erie, Pa. 519
Nathaniel Tufts Meter Co., Boston, Mass. 518
New York Improved Meter Co., New York City. 518
Pittsburg Meter Co., East Pittsburg, Pa. 508
Rotary Meter Co., New York City. 491
Sprague Meter Co., Bridgeport, Conn. 517

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia. 519
D. McDonald & Co., Albany, N. Y. 517
Helme & McIlhenny, Philadelphia, Pa. 519
John J. Griffin & Co., Philadelphia, Pa. 472
Keystone Meter Co., Royersford, Pa. 518
Nathaniel Tufts Meter Co., Boston, Mass. 518
New York Improved Meter Co., New York City. 518
Pittsburg Meter Co., East Pittsburg, Pa. 508
Sprague Meter Co., Bridgeport, Conn. 517

PREPAYMENT METER ATTACHMENTS.

New York Improved Meter Co., New York City. 518

WATER METERS.

Pittsburg Meter Co., East Pittsburg, Pa..... 503

GAS AND WATER PIPES.

Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Donaldson Iron Co., Emaus, Pa..... 504
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
R. D. Wood & Co., Philadelphia, Pa..... 514

GAS COALS.

Berwind-White Coal Mining Co., New York and Phila. 500
Perkins Co., New York City..... 500
Westmoreland Gas Coal Co., Philadelphia, Pa..... 511

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., New York City..... 511

MAIN AND SERVICE LAYING.

Sullivan Bros., Flushing, N. Y..... 511

GAS TAPPING MACHINES.

George Light, Dayton, O..... 511
H. Mueller Manufacturing Co., Decatur, Ills..... 495

CANNEL COALS.

Perkins & Co., New York City..... 510

STOKING MACHINERY.

G. A. Bronder, New York City..... 509
Laclede-Christy Clay Products Co., St. Louis, Mo..... 508
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 497

CONVEYORS—ALL KINDS.

Bartlett-Hayward Co., Baltimore, Md..... 513
Cruse-Kemper Co., Philadelphia, Pa..... 500
C. W. Hunt Company, New York City..... 504
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
G. A. Bronder, New York City..... 499
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
The Gas Machinery Co., Cleveland, O..... 492
The Stacey Mfg. Co., Cincinnati, O..... 515
Western Gas Construction Co., Fort Wayne, Ind..... 520

CHARGING BARROWS & COAL WAGONS.

Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
The Stacey Mfg. Co., Cincinnati, O..... 515

GAS ENRICHERS.

Standard Oil Co., New York City..... 511

COKE CRUSHERS.

Bartlett-Hayward Co., Baltimore, Md..... 513
C. M. Keller, Columbus, Ind..... 511

GAS METER CONNECTIONS.

H. Mueller Manufacturing Co., Decatur, Ills..... 495

GAS COCKS.

H. Mueller Manufacturing Co., Decatur, Ills..... 495

GAS GAUGES.

The Bristol Co., Waterbury, Conn..... 504

GAS GOVERNORS.

Chaplin-Fulton Mfg. Co., Pittsburg, Pa..... 510
Connelly Iron Sponge & Governor Co., New York City. 509
Evens & Howard Firebrick Co., St. Louis, Mo..... 498
Isbell-Porter Co., Newark, N. J..... 500
Pittsburg Meter Co., East Pittsburg, Pa..... 499
Reynolds Gas Regulator Co., Anderson, Ind..... 509

CEMENTS.

C. L. Gerould, New Castle, Pa..... 508
Laclede-Christy Clay Products Co., St. Louis, Mo..... 508
Strassburger Bros., Chicago, Ills..... 508

RETORTS AND FIREBRICKS.

Baltimore Retort and Firebrick Co., Baltimore, Md... 508
Chamber Oven Co., Milwaukee, Wis..... 491
Didier-March Co., New York City..... 493
Evens & Howard Firebrick Co., St. Louis, Mo..... 498
Gas Bench Construction Co., St. Louis, Mo..... 501
Henry Maurer & Son, New York City..... 501
Improved Equipment Company, New York City..... 494
James Gardner, Jr., Co., Bolivar, Pa..... 510
J. H. Gautier & Co., Jersey City, N. J..... 508
Laclede-Christy Clay Products Co., St. Louis, Mo..... 508
Missouri Firebrick Co., St. Louis, Mo..... 508
Parker-Russell Mining and Mfg Co., St. Louis, Mo.... 497

INCLINED RETORTS.

Baltimore Retort and Firebrick Co., Baltimore, Md... 508
Didier-March Co., New York City..... 493
Gas Bench Construction Co., St. Louis, Mo..... 501
Improved Equipment Company, New York City..... 494
Laclede-Christy Clay Products Co., St. Louis, Mo..... 508
Parker-Russell Mining and Mfg. Co., St. Louis, Mo... 497

VERTICAL 8's.

Connelly Iron Sponge & Gov. Co. (Drake's [Eng.] System) 509
Didier-March Co., New York City..... 493
Gas Bench Construction Co., St. Louis, Mo..... 501
Improved Equipment Company, New York City..... 494
Laclede-Christy Clay Products Co., St. Louis, Mo..... 508
Parker-Russell Mining and Mfg. Co., St. Louis, Mo... 497

REGENERATIVE FURNACES.

Baltimore Retort and Firebrick Co., Baltimore, Md.. 508
Bartlett, Hayward & Co., Baltimore, Md..... 513
Didier-March Co., New York City..... 493
Gas Bench Construction Co., St. Louis, Mo..... 501
Improved Equipment Company, New York City..... 494
J. H. Gautier & Co., Jersey City, N. J..... 508
Laclede-Christy Clay Products Co., St. Louis, Mo..... 508
Missouri Firebrick Co., St. Louis, Mo..... 498
Parker-Russell Mining and Mfg. Co., St. Louis, Mo... 497

SELF-SEALING MOUTHPIECE DOORS.

Bartlett-Hayward Co., Baltimore, Md..... 513
Continental Iron Works, Brooklyn, N. Y..... 514
Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Isbell-Porter Co., Newark, N. J..... 500
Improved Equipment Company, New York City..... 494
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
Parker-Russell Mining and Mfg. Co., St. Louis, Mo..... 497
Quintard Iron Works, New York City..... 501
R. D. Wood & Co., Philadelphia, Pa..... 514
The Gas Machinery Co., Cleveland, O..... 492
The Stacey Mfg. Co., Cincinnati, O..... 515
Western Gas Construction Co., Fort Wayne, Ind..... 520

INCANDESCENT GAS LAMPS.

General Gas Light Co., Kalamazoo, Mich..... 497
Welsbach Company, Gloucester, N. J..... 506

BURNERS.

Wm. M. Crane Co., New York City..... 504

STREET LAMPS.

Thos. T. W. Miner, New York City..... 501
Welsbach Street Lighting Co., New York and Phila.. 506

GAS BLAST FURNACES.

American Gas Furnace Co., New York City..... 502

PURIFIERS.

Bartlett-Hayward & Co., Baltimore, Md..... 513
Connelly Iron Sponge & Governor Co., New York City. 509
Cruse-Kemper Co., Philadelphia, Pa..... 500
Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Isbell-Porter Co., Newark, N. J..... 500
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
Quintard Iron Works, New York City..... 501
R. D. Wood & Co., Philadelphia, Pa..... 514
The Stacey Mfg. Co., Cincinnati, O..... 515
The United Gas Improvement Co., Philadelphia, Pa... 507
Western Gas Construction Co., Fort Wayne, Ind..... 520

VALVES.

Bartlett-Hayward & Co., Baltimore, Md..... 513
Continental Iron Works, Brooklyn, N. Y..... 510
Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Isbell-Porter Co., Newark, N. J..... 500
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
Ludlow Valve Manufacturing Co., Troy, N. Y..... 501
R. D. Wood & Co., Philadelphia, Pa..... 514
The Gas Machinery Co., Cleveland, O..... 502
The P. H. & F. M. Roots Co., Connersville, Ind..... 503
The Stacey Mfg. Co., Cincinnati, O..... 515
Western Gas Construction Co., Fort Wayne, Ind..... 520

(*Continued on page* 490.)

Position Wanted
As Superintendent,

By a competent gas man who has had practical experience in all branches of the business, both coal and water gas. At present employed. A-1 references.

1755-tf Address, "R. C.," care this Journal.

Position Wanted.

A married man, 31 years of age, with 9 years' experience in all branches of the gas business, wishes a position as superintendent or maaager of a small or medium size water gas company. Thoroughly experienced in getting results on large or small water gas sets, also new business. At present employed by one of the largest operating companies in the United States. Best of references furnished.

1780-tf Address, "S. H. P.," care this Journal.

Position Wanted
As a First-Class Gas Meter Repairer and Tester.

Also will assist in pipe fitting and general complaint work. Experience, 18 years. City of 30,000 to 60,000 inhabitants in Central West preferred.

1784-1 Address, "ANSWER," care this Journal.

Position Wanted.
First-Class Repairer, Tester and Prover on Prepaid and Ordinary Gas Meters.

An all-round meter man, with a thorough knowledge of the routine work of a meter repair shop, desires to take charge of a repair shop with gas company in large or small city. A-1 references. Address, "SHOPMAN,"

1784-1 Care this Journal.

WANTED,
A Position as Superintendent

Of manufacturing or construction of water or coal gas plant, or all. Have been acting in this capacity in a city of 100,000 population. Can give best of references. Address, "M. E.,"

1783-2 Care this Journal.

Position Wanted
By a Competent, Energetic and Reliable Gas Man,

Thirty-three years of age, married, strictly sober, and one who can show results. Good technical education, with 13 years of thorough practical experience in all departments of the gas business. Either coal, water or natural gas. At present employed as manager in a city of 36,000 inhabitants. Can furnish first-class references from present employers, as well as others, and willing to go anywhere. Address BOX No. 22,

1782-5 Care this Journal.

Position Wanted.
Experienced Solicitor

Wants position. Has always made good. Employed in present position for past 3 years, but wishes to make a change. Address, "G. O.,"

1784-1 Care this Journal.

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Fifteen years' practical experience in the manufacture and distribution of water and coal gas. Married. Good references from past employers. Open to accept at once. Address, "Y.,"

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Retort House Foreman for 30,000,000 Coal Gas Plant.

Applicant should preferably, but not necessarily, have had water gas experience, and must be experienced in the handling of negro retort house labor. Wages, $75 per month to one who can show results. Address, "RETORT,"

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FOR SALE,

One set of 4 purifying boxes 12 feet 8 inches by 10 feet 9 inches by 3 feet, in good condition, with centerseal and 10-inch connections. Also one American 8-foot station meter.

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(Concluded from page 489.)

PURIFYING MATERIALS.

Connelly Iron Sponge & Governor Co., New York City 509
F. Behrend, New York City..... 490
The United Gas Improvement Co., Philadelphia, Pa... 507

EXHAUSTERS.

Connelly Iron Sponge & Governor Co., New York City 509
Connersville Blower Company, Connersville, Ind..... 516
Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Isbell-Porter Company, Newark, N. J..... 500
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
Piqua Blower Co., Piqua, O..... 501
The P. H. & F. M. Roots Co., Connersville, Ind..... 503

HIGH PRESSURE GAS GOODS.

H. Mueller Manufacturing Co., Decatur, Ills..... 495

PURIFIER AND SCRUBBER TRAYS.

Bartlett-Hayward Co., Baltimore, Md..... 513
Cabot Mfg. Co., Hoboken, N. J..... 511
Western Gas Construction Co., Fort Wayne, Ind..... 520

PIPE LINE TOOLS.

H. Mueller Manufacturing Co., Decatur, Ills..... 495

GAS PLANT TOOLS.

H. Mueller Manufacturing Co., Decatur, Ills..... 495

GAS STOVES.

American Meter Co., New York and Philadelphia..... 505
Keystone Meter Co., Royersford, Pa..... 518
Maryland Meter & Manufacturing Co., Baltimore, Md... 518
Nathaniel Tufts Meter Co., Boston, Mass..... 518

HOT WATER HEATERS.

Humphrey Co., Kalamazoo, Mich..... 503

GASHOLDERS.

Bartlett-Hayward Co., Baltimore, Md. 513
Continental Iron Works, Brooklyn, N. Y..... 510
Cruse-Kemper Co., Philadelphia, Pa..... 500
Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Deily & Fowler Mfg. Co., Philadelphia, Pa..... 516
Economical Gas Apparatus Construc. Co., Toronto, Ont. 490
Kerr Murray Mfg. Co., Fort Wayne, Ind..... 513
R. D. Wood & Co., Philadelphia, Pa..... 514
Riter-Conley Mfg. Co., Pittsburgh, Pa..... 499
The Stacey Mfg. Co., Cincinnati, O..... 515
Western Gas Construction Co., Fort Wayne, Ind..... 520

STORAGE TANKS.

Bartlett-Hayward Co., Baltimore, Md..... 513
Davis & Farnum Mfg. Co., Waltham, Mass..... 512
Quintard Iron Works, New York City..... 501
The Stacey Mfg. Co., Cincinnati, O..... 515
Western Gas Construction Co., Fort Wayne, Ind..... 520

LEATHER BELTING.

Chas. A. Schieren Co., New York City..... 496

PATENTS, TRADE-MARKS AND COPYRIGHTS.

Royal E. Burnham, Washington, D. C..... 511

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IMPROVED AMMONIA CONCENTRATOR.
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AND
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The former showing at a glance 69 accounts and the latter 55 accounts of Coal and Water Gas Companies, itemized under

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One-tenth the space
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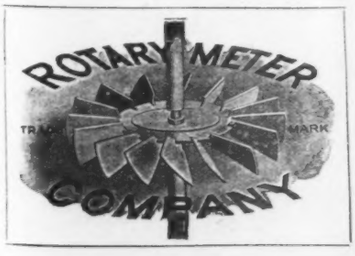

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OF PHILADELPHIA

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Main Office
Welsh and Sixth Streets.
CHESTER, PA.

July 23, 1909.

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Rotary Meter Company,
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Replying to your letter of the 22nd instant would say that your Rotary Meter installed May 1907 has given us continuous satisfaction. Periodically we check it up with our wet station meter by passing the same quantity of gas through both meters and find the registration very nearly identical, considerably less than 1% apart. From the continued use of this meter we have as much confidence in its registration as in the ordinary wet station meter.

Yours very truly,

J. D. Shattuck

General Manager.

P. PLANTINGA, President W. E. STEINWEDELL, Secretary

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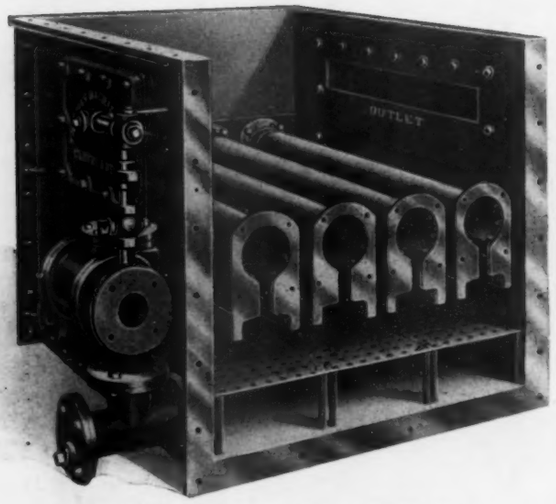

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GETTING REPEAT ORDERS HAS ALWAYS BEEN CONSIDERED GOOD EVIDENCE OF SATISFACTORY MATERIAL, SUPERIOR WORKMANSHIP AND FAIR TREATMENT.

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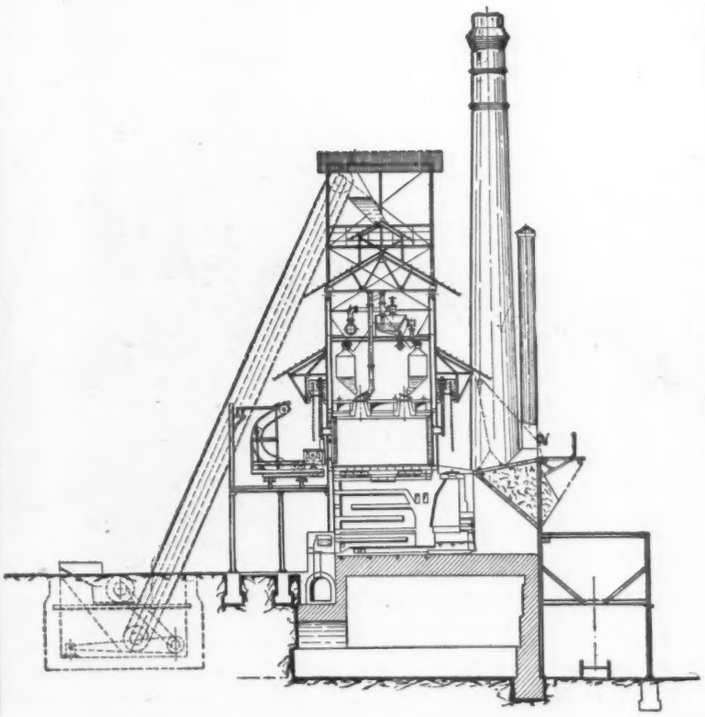
Do You Know About Chamber Ovens?

Horizontal, Vertical, or Inclined.



If your output is over 250,000 feet per diem don't fail to consult

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The Round Up For The Year.

The "round up" for the year is here.

It's the time when we all begin to shape the conclusion of the year's business.

Some of the big jobs are finished, some are still hanging over, and there are small contracts here and there to be completed.

No matter, however, whether it's big or little, the time to "round up" has come. It's a good time to get your bearings on what is yet needed in the way of tapping machines, high or low pressure gas cocks, meter connections, service clamps, tools, etc., to complete the season,

We are in a position to fill orders from stock promptly for anything in the gas goods line and thereby make your 1909 finish easy.

Mueller Gas goods are Unconditionally Guaranteed.

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Beats all others combined and has none of their faults

Owning up to the "Old Man" that the belting slipped and burned is an unpleasant experience for any engineer. It hurts his pride, spoils his chance for a "raise" and costs the concern money in lost power and leather.

Schieren's Flyfoot Belt Dressing absolutely prevents slippage—but not in the STICKY way. More, it preserves the belting.

Send $2.00 for a five-pound tin of "Flyfoot." Give it a fair trial. If you don't want to keep it, return it and your money will go back to you.

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ESTABLISHED 1868

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Longest life—largest output per retort—lowest fuel results—greatest ease of operation.
Water Gas Linings.
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Large stock of retorts and settings on hand.
All our wares are manufactured at our own plant from clays mined at our mines.

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Has been one of the most conspicuous successes of the past decade in lighting lines. The competing lamps that were brought out in scores during the earlier days had but a brief life and exist to-day principally as unpleasant memories of ill-considered purchases. **Is not the same thing about to be repeated with Inverted Gas Arc Lamps?**

Adopt the **Humphrey Inverted** as your standard and be insured and protected by the strongest, most liberal and progressive gas lighting organization in the world.

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GAS ENGINES,

With Instructions for Care and Working of the Same,

By G. LIECKFELD, C.E.

Translated with Permission of the Author, GEO. M. RICHMOND, M.E.

PRICE, $1.00.

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EVENS & HOWARD FIRE BRICK CO

LITTLE HINTS.

Arnold says, "Calm is the most important of all conditions leading to the highest possible labor-hour production, which is the highest pos-ible human good."

You will perhaps wonder what application this has to your case. Take as an instance your retort house work. May it not be the case that, owing to the many and multifarious duties which you perform, your orders for gas retort benches were placed with the company who put up a claim for the work, when a little investigation would have shown a better bench could have been gotten from another company at a lower price? Do you feel that "calm" which leads to the highest labor-hour production when you know more surely day by day it is only by strenuous work on repairs, coaxing of heats and hard talks with the stokers, you are able to show good production? Your time is valuable, and can be well employed thinking out new ways for internal and external economis, and better schemes for increasing sales. The more time you have with nothing necessary to do the more time and inclination you have to do something well worth doing. There is no chance to think when the poor work of the other man gives you continuous active work.

YOU are the thinking part of your commercial machine.

Here's another phase of the question. The man who acts is in the retort house or other manufacturing section of the business.

He works best when he does nothing but work. He is not supposed to have to think. Actually when his "calm" is disturbed he must think or the interests of your company suffer. A cracked retort, a stopped standpipe, pitch in the mains, collapsed furnace walls, imperfect steam supply, leaky recuperators, one and all are disturbers of the peace. It is a good job the American workman can think. If he is not compelled to think he can work to perfection. If he has to think he "is there with the goods." But his value to you is as a workman, and your value to yourself and your company is as a thinking and reasoning engineer.

By studying carefully every detail of a retort bench before you order it installed, you will not need to give it much thought after it is in use.

The way to enjoy "calm" is surely, know what you need, ask for what you want, and be sure you get what you require.

We are trying to make what you want. If we have not succeeded it is because you have not TOLD us what you want.

GAS WORKS DIVISION, - - - - - - - - - - A. S. B. LITTLE, Engineer.

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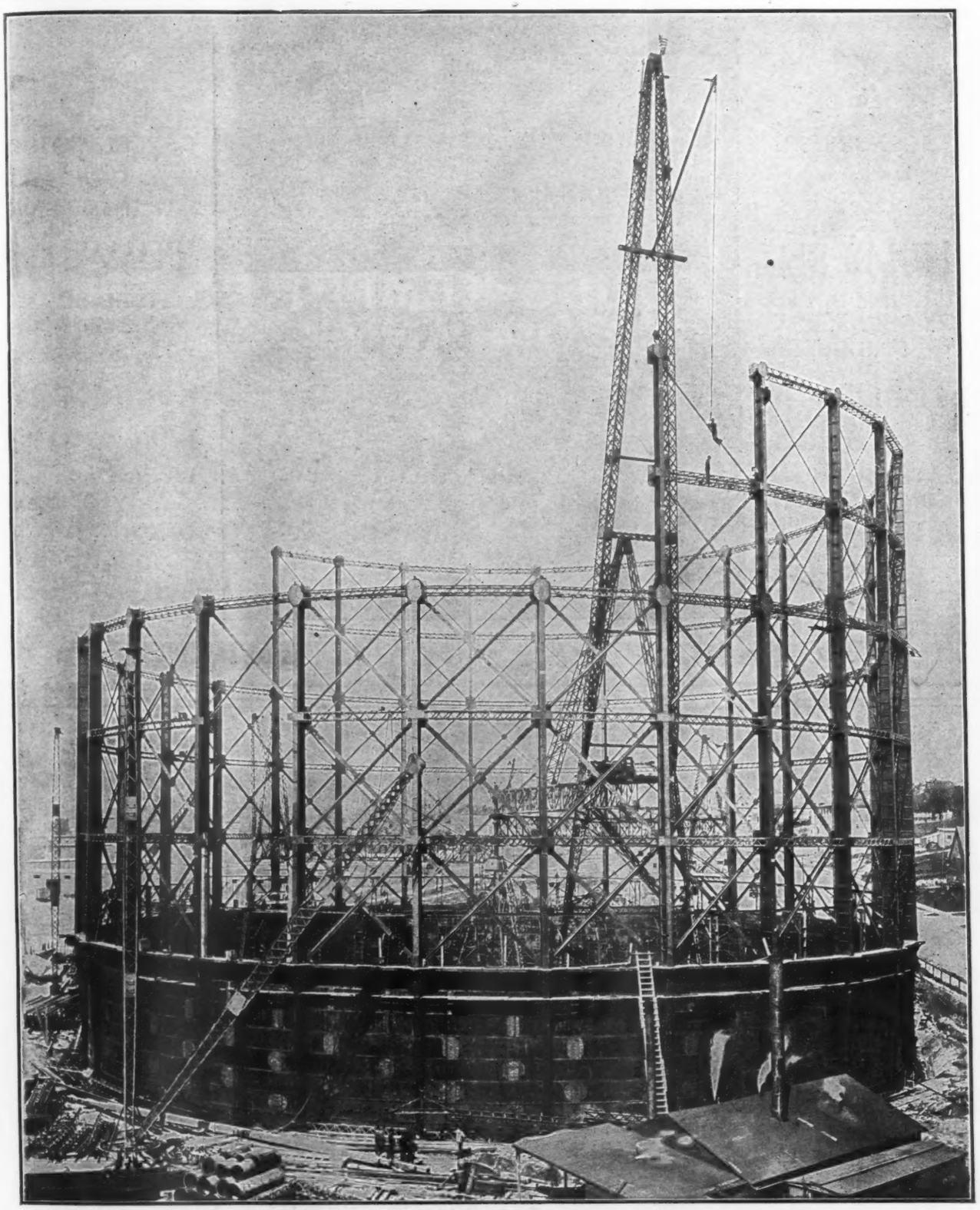

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PLATE AND STRUCTURAL WORK OF EVERY DESCRIPTION.

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STEEL TANKS,
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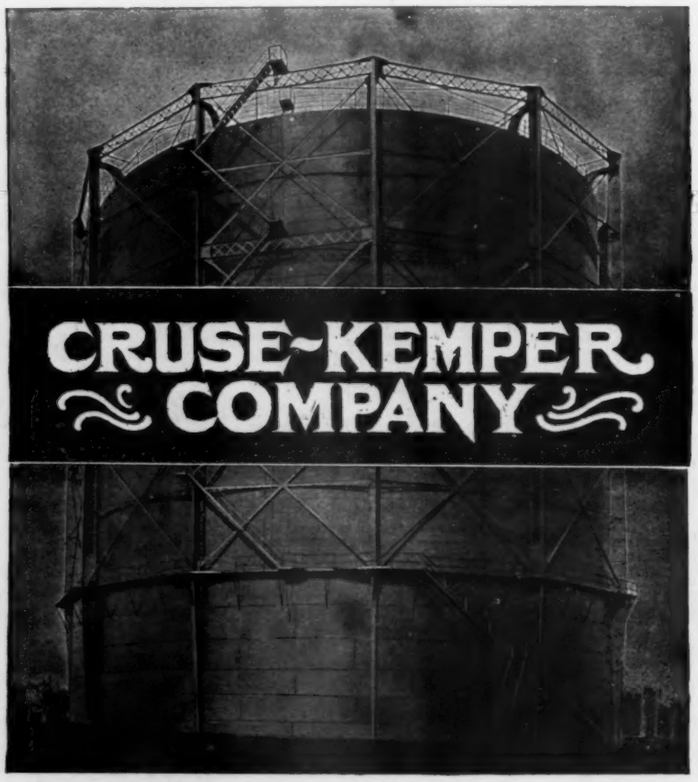

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STRUCTURAL IRON & STEEL WORK IN GENERAL.

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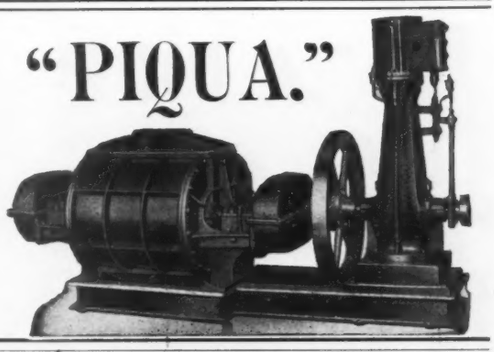

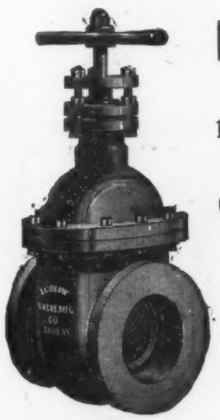

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TROY, N. Y., U. S. A.
Double and Single Gate Valves, ¼" to 72",
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Gas, Water, Steam, Oil, Ammonia, Etc.

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By G. LIECKFELD, C.E. Translated with Permission of the Author, by GEORGE M. RICHMOND, M.E. Price, $1.
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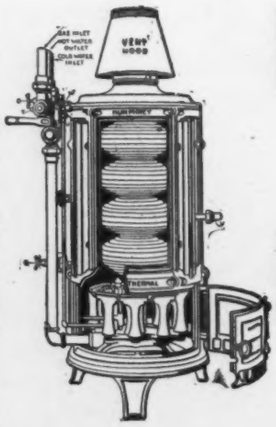

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Have every known desirable feature helping to efficiency, economy, durability and absolute safety.

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—FOR—

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This Edition of the "Handbook for Gas Engineers and Managers" is a great improvement on all previous editions. Much of the text has been re-written, in order to keep the work abreast of the constant advances that are being made in the Gas Industry.

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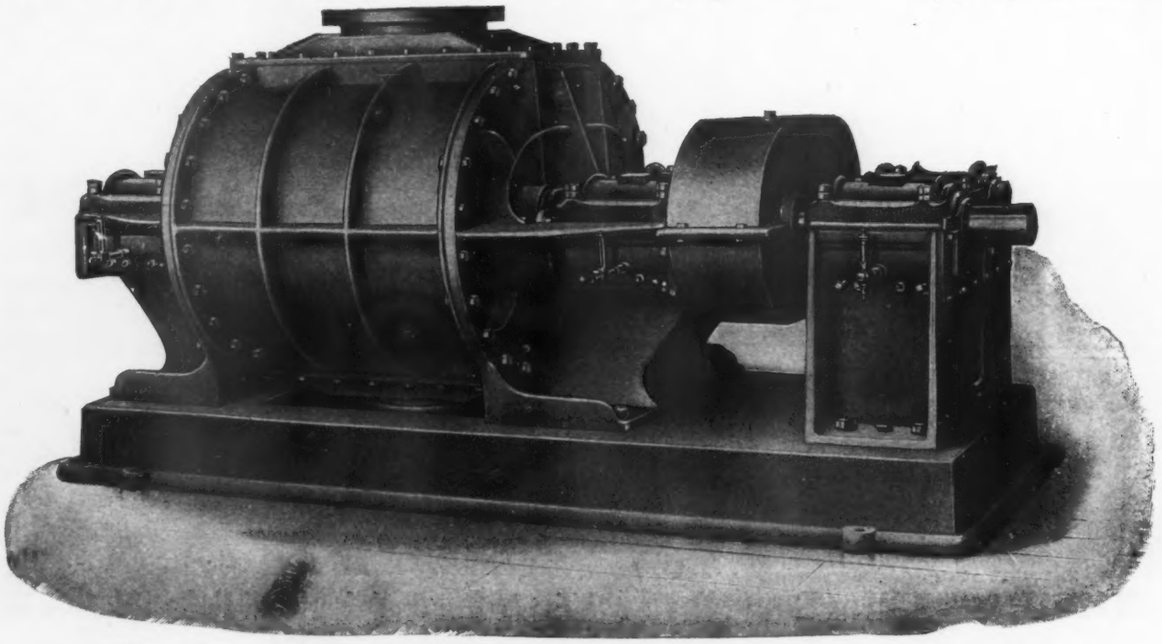
ROOTS' EXHAUSTERS FOR HIGH AND LOW PRESSURE WORK.

The highest efficiencies obtained. Most perfect devices for adjustment and maintenance of proper alignment. Use our flexible coupling to correct troubles caused by misalignment and engine shaft thrust. Our gas governor is the best. By-pass, gas valves and fittings.



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GLOBE STREET LAMPS.

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THE BEST STREET LAMPS for ALL KINDS OF GAS OR BURNERS.

This is only one of a Large Variety of Styles.

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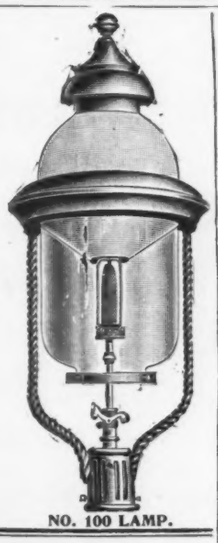

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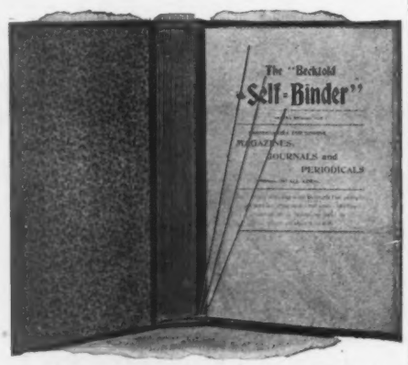

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IRONCLAD Cast Iron, Dry Gas Meters

Larger capacity with a given absorption than any other meter, and

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RECORDING GAUGES

For All Commercial Ranges of

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THE BRISTOL CO., WATERBURY, CONN.

"HUNT" LABOR-SAVING MACHINERY FOR GAS WORKS.

McDonald-Mann Quenching Chutes.
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McDONALD-MANN QUENCHING CHUTES.

Special Features are:

The Coke is quenched and dried when drawing from the Retort and Quenching Chute is completed.

Approximately only a pound of water is used to quench a pound of coke.

The Quenched Coke has a silvery luster.

No loss from incipient combustion.

Charging room is free from steam and gases.

Gas Engineers are particularly invited and requested to visit any of the Gas works equipped with our machinery easy of access from their vicinity. :: :: :: :: :: ::

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EVERYONE INTERESTED IN GAS MATTERS

Should have a Copy of our 50th Anniversary Number (Price, 50c.), Containing the Following Articles:

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Fifty Years of Street Lighting in the City of New York. H. Thurston Owens.

Historical Notes Respecting the Development of the Last Half Century in the Gas Business of the Pacific Coast. John A. Britton.

Processes I Have Known. Frederic Egner.

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Gas Coals of America. James D. Perkins.

A Half-Century History of Water Gas. F. N. Morton.

The Development of the Public Utilities Commissions as Applied to the Gas and Electric Business. C. J. Russell Humphreys.

A Half-Century's History of Gaseous Fuel as Applied to Heating Gas Retorts. F. Bredel.

Systems of Vertical Retorts. Fred. J. Mayer.

Development of the Ammonia Industry in Gas Works during the Last 50 Years. R. W. Hilgenstock.

Residuals, Some History of. Carroll Miller.

Meters and Meter Makers. D. McDonald.

Progress in Electric Current Development in the Artificial Lighting Field. A. F. Ganz.

Development of the New Business Division of the Gas Industry during the Last 50 Years. Philmer Eves.

Growth and Value of Demonstration Work in the Household of Gaseous Fuel. Helen Armstrong.

"Uncle Jerry" in Reminiscent Mood. J. B. Howard.

Present-Day Photometrical Practice. W. H. Gartley.

The Boston Gas Supply during 50 Years. William McKay.

Development in Pipe Manufacture. George W. Whyte.

Public Utility Commissions. Rufus C. Dawes.

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Photometrical and Experimental Apparatus.

PUBLIC LIGHTING TABLE.

SEPTEMBER, 1909.

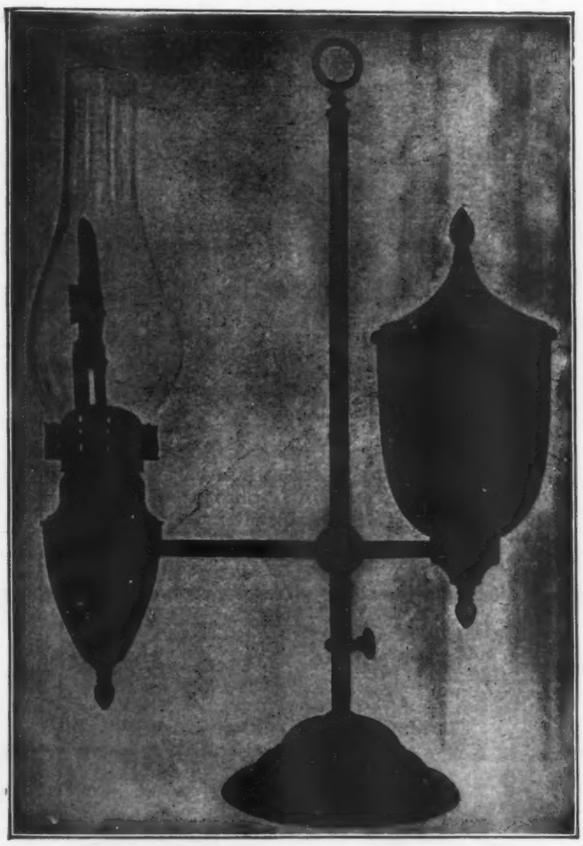
Table No. 1.
FOLLOWING THE MOON.

Day of Week.	Date.	Light.	Extinguish.
Wed.	1	7.00PM	8.50PM
Thu.	2	7.00	9.20
Fri.	3	7.00	9.50
Sat.	4	7.00	10.20
Sun.	5	6.50	11.00
Mon.	6	6.50LQ	11.40
Tue.	7	6.50	12.30AM
Wed.	8	6.50	1.20
Thu.	9	6.50	2.20
Fri.	10	6.50	3.20
Sat.	11	6.50	4.40
Sun.	12	6.40	4.40
Mon.	13	6.40	4.40
Tue.	14	6.40NM	4.40
Wed.	15	6.40	4.40
Thu.	16	6.40	4.40
Fri.	17	6.40	4.40
Sat.	18	6.40	4.40
Sun.	19	7.40	4.50
Mon.	20	8.10	4.50
Tue.	21	8.50	4.50
Wed.	22	9.40FQ	4.50
Thu.	23	10.30	4.50
Fri.	24	11.40	4.50
Sat.	25	12.50AM	4.50
Sun.	26	2.10	4.50
Mon.	27	3.20	4.50
Tue.	28	No L.	No L.
Wed.	29	No L.FM	No L.
Thu.	30	No L.	No L.

TOTAL HOURS DURING 1909.

By Table No. 1.

	Hrs.Min.
January	212.20
February	183.40
March	173.00
April	151.10
May	144.10
June	138.50
July	145.40
August	160.30
September	180.00
October	201.00
November	216.30
December	233.40
Total, yr.	2140.30



THE ELLIOTT KEROSENE STANDARD PHOTOMETER LAMP.

***

10-Candle Power.

***

This lamp is a perfect substitute for the 10-candle Pentane Lamp hitherto used, and has the following advantages:

1st. It uses Standard Kerosene Oil (Pratt's Astral Oil or equivalent).

2d. It is remarkably steady. Will burn 24 hours continuously with less than 2 per cent. variation.

3d. It is much less dangerous than Pentane, which is a kind of gasolene.

4th. It is not easily affected by air currents in the photometer room.

5th. Since the lamp may burn continuously, the candle power of gas may be taken at any moment, if necessary. This insures steady illuminating power without waste of carburetting material.

6th. The first cost of the lamp brings it within the reach of even small gas works.

7th. Costs much less to maintain than a Pentane lamp or sperm candles doing the same service.

8th. Is not affected by the weather.

PUBLIC LIGHTING TABLE.

SEPTEMBER, 1909.

Table No. 2.
NEW YORK CITY.
All Night Lighting.

Day of Week.	Date.	Complete Lighting in One Hour From Time Given P. M.	Complete Extinguishing in 50 Minutes From Time Given A.M.
Wed.	1	6.27	3.57
Thu.	2	6.27	3.57
Fri.	3	6.17	4.07
Sat.	4	6.17	4.07
Sun.	5	6.17	4.07
Mon.	6	6.17	4.07
Tue.	7	6.12	4.07
Wed.	8	6.12	4.07
Thu.	9	6.12	4.07
Fri.	10	6.02	4.17
Sat.	11	6.02	4.17
Sun.	12	6.02	4.17
Mon.	13	6.02	4.17
Tue.	14	6.02	4.17
Wed.	15	6.02	4.17
Thu.	16	6.02	4.17
Fri.	17	5.52	4.27
Sat.	18	5.52	4.27
Sun.	19	5.52	4.27
Mon.	20	5.52	4.27
Tue.	21	5.47	4.27
Wed.	22	5.47	4.27
Thu.	23	5.47	4.27
Fri.	24	5.37	4.37
Sat.	25	5.37	4.37
Sun.	26	5.37	4.37
Mon.	27	5.37	4.37
Tue.	28	5.32	4.37
Wed.	29	5.32	4.37
Thu.	30	5.32	4.37

TOTAL HOURS DURING 1909.

	Hrs.Min.
January	428.30
February	358.15
March	353.10
April	298.10
May	263.20
June	234.45
July	248.30
August	278.00
September	311.25
October	370.05
November	397.40
December	438.35
	3980.25
Deduct on account of 50 min. extinguishing time	30.25
Total, yr.	3950.00

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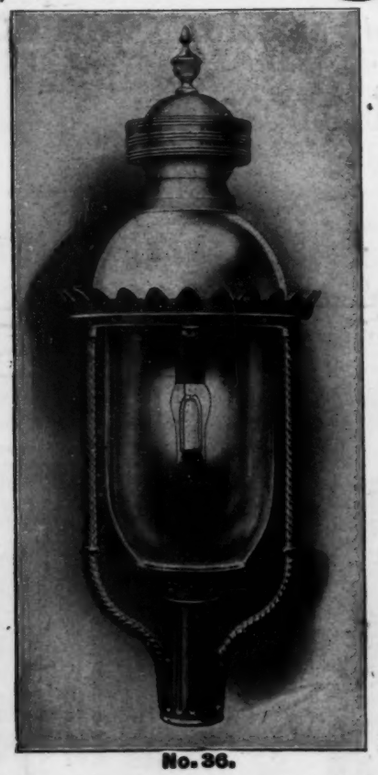

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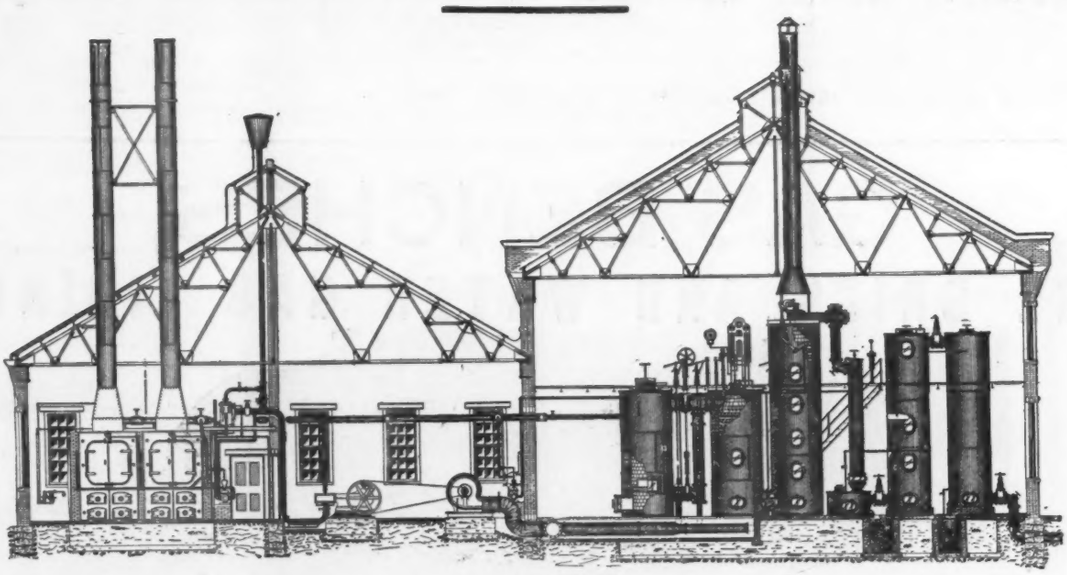

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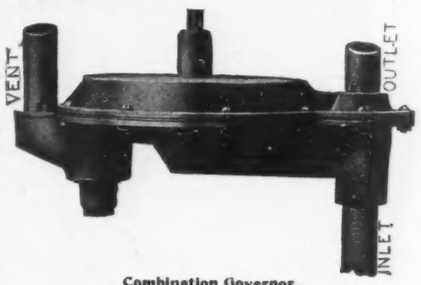

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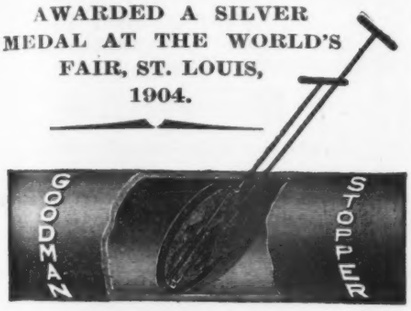

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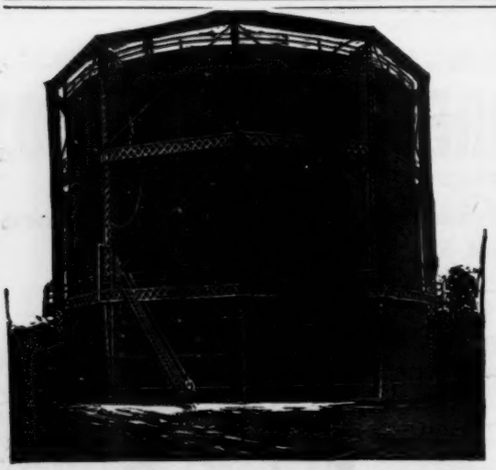

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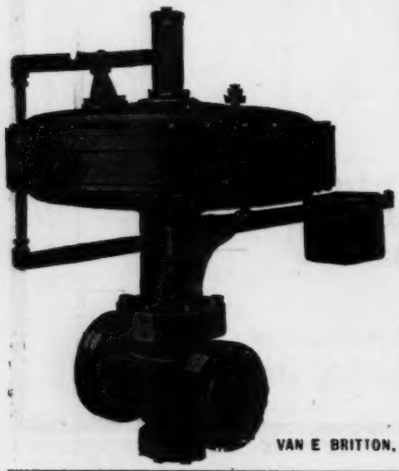

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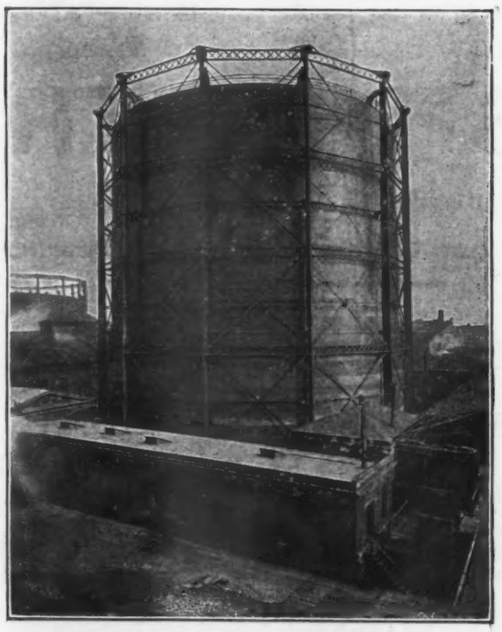

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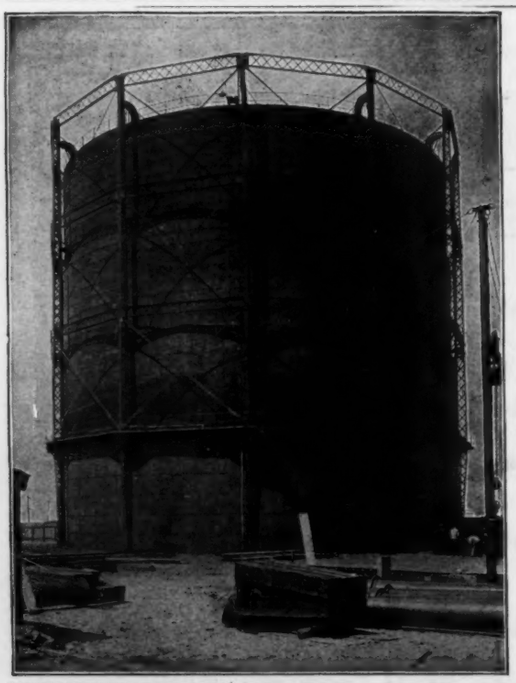

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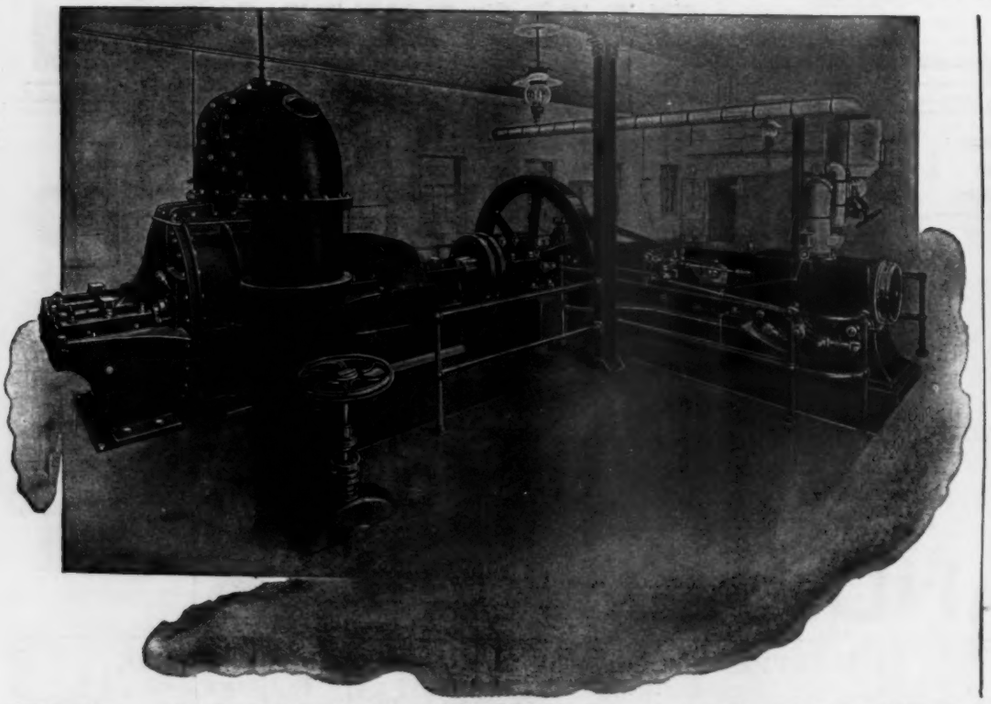

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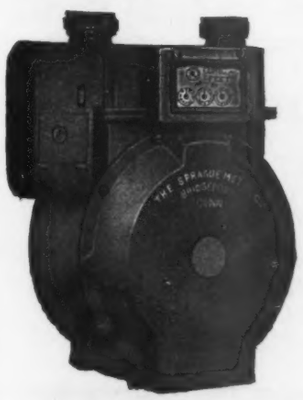

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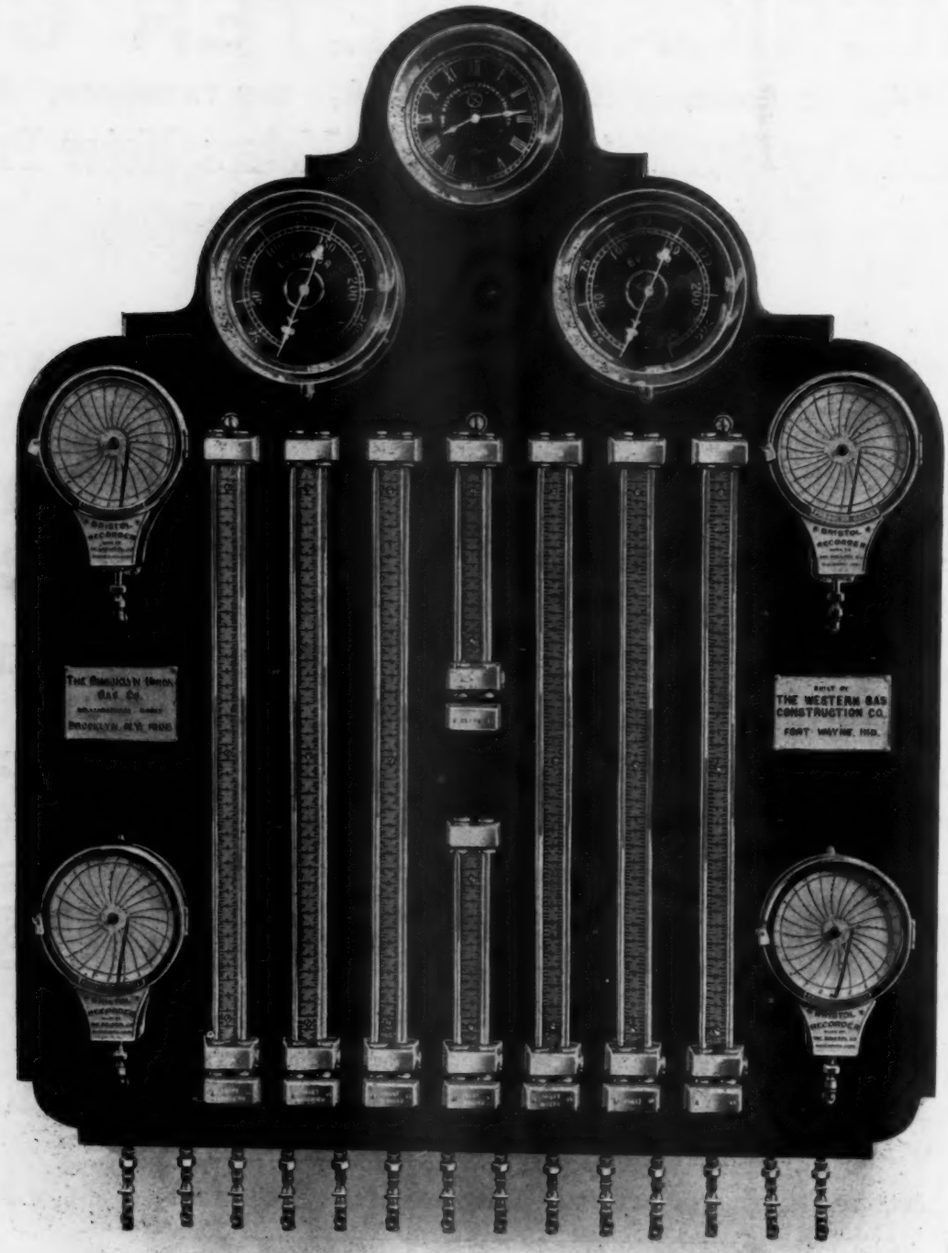

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